October 2002

Process Control Instrument Division

TMO2D Oxygen Analyzer

User's Manual *910-084A5*

!ATTENTION!
This manual contains instructions for TMO2D units that use software versions STD.004.E or earlier. Units manufactured in Waltham with serial numbers below 1350 or in Shannon with serial numbers below 300E were supplied with these software versions.

PANAMETRICS

TMO2D Oxygen Analyzer

Warranty

The TMO2D Oxygen Analyzer is warranted by PANAMETRICS to be free from defects in material and workmanship. Liability under this warranty is limited to servicing, calibrating and replacing any defective parts of the instrument. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. For the warranty to be valid, the equipment must be determined by Panametrics to have been defective. This warranty is effective with respect to the following:

- one year for electronic failures
- one year for mechanical failures (shorts or opens) to the transmitter

If damage is determined to have been caused by misuse or abnormal conditions of operation, the owner will be notified and repairs will be billed at standard rates after approval.

Maintenance Policy

If any problems develop, take the following steps:

- Notify PANAMETRICS, giving full details of the problem. Be sure to include the model and serial number of your O2 Analyzer. PANAMETRICS will then give you a RETURN AUTHORIZATION NUMBER if the analyzer has to be returned to the factory.
- If PANAMETRICS instructs you to send your O2 Analyzer back to the factory, please send it prepaid to the authorized repair station as indicated in the shipping instructions.
- If damage has been caused by misuse, abnormal conditions, or if the warranty has expired, an estimate will be made and provided upon request before repairs are started.

The PANAMETRICS TMO2D Oxygen Analyzer warranty is limited to that which is stated above; PANAMETRICS will not be liable for anything beyond this.

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Chapter 1

Features and Capabilities

Introduction to the TMO2D 1-1

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Introduction to the TMO2D

In this section you will find the following:

- An introduction to the TMO2D Oxygen Analyzer and its components
- A description of the TMO2D configurations and accessories
- A brief discussion of the TMO2D operating system

The TMO2D Oxygen Analyzer is a complete system that measures oxygen concentration from 0-100% in gaseous mixtures. The main components of the Analyzer are the TMO2 Transmitter (a measuring cell mounted within an aluminum housing) and the TMO2D Electronic Display.

The TMO2D Electronic Display is connected to the TMO2 Transmitter via a 3- or 4-wire non-shielded cable. The Electronic Display provides user-friendly software that allows you to enter parameters specific to your process application, i.e., your O_2 range, recorder output range, alarm settings, etc.

System Description

The TMO2D Oxygen Analyzer is configured with the following components and accessories:

- The TMO2 Transmitter
- The TMO2D Electronic Display
- The Sample System (specific to your application) on which the Transmitter is mounted
- A three- or four-wire color coded cable, T(*) N4

Note: *All applications require a sample system; consult Panametrics whether you are ordering a sample system or planning to build one.*

The TMO2 Transmitter

The TMO2 Transmitter is self-contained, consisting of the oxygen measuring cell and associated electronics enclosed in a cast aluminum housing (see Appendix B for outline and installation dimension drawings).

The Transmitter has no moving parts. It requires 24 VDC power and outputs a 4-20 or 0-20 mA signal proportional to oxygen concentration. It can also output an optional pressure or background gas compensation signal. The Transmitter housing is weatherproof and can be made explosion-proof with inlet and outlet flame arrestors (see Figure 1-1 below).

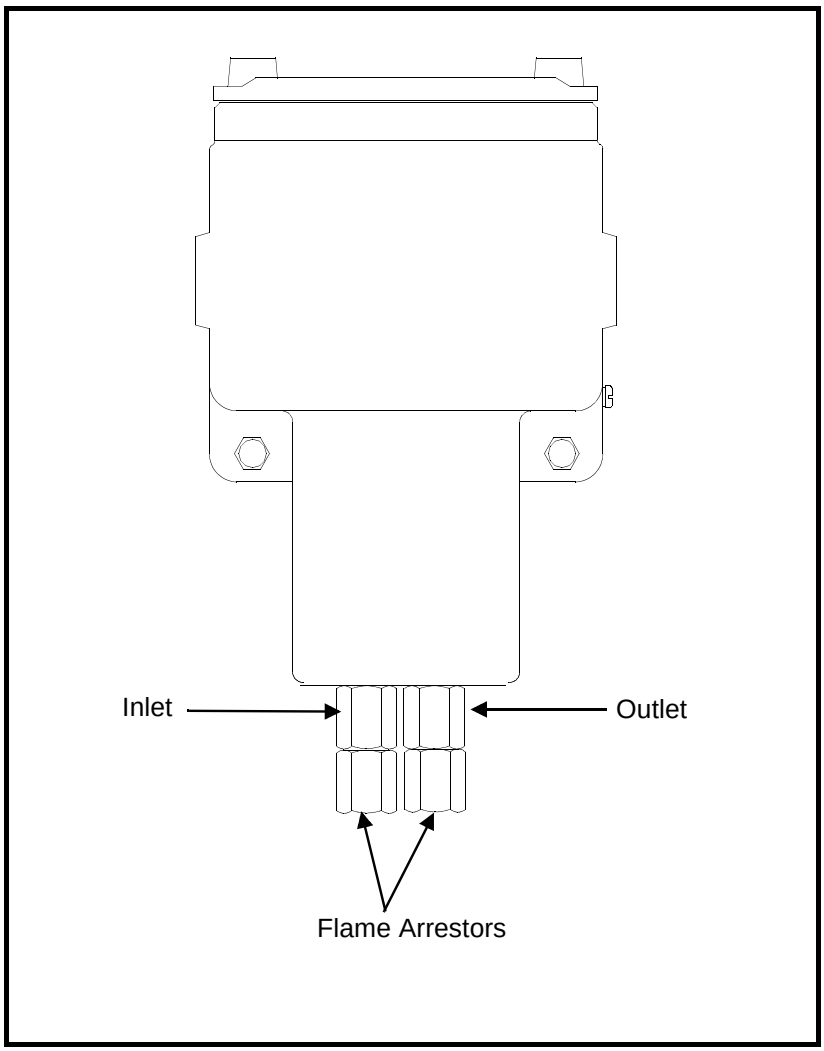

Figure 1-1: TMO2 Transmitter with Inlet and Outlet Piping

The TMO2D Electronics Display

The TMO2D Electronics Display is an electronic module containing user-friendly software that allows you to enter specific parameters for O_2 range, recorder output range, alarm settings, etc. The Display features a two-line by 24-character backlit liquid crystal display (LCD) and comes in either rack, bench, panel or weatherproof configurations. A color-coded cable is used to connect the Display to the Transmitter.

The Sample System

A Sample System is required to bring a gas sample flow to the Transmitter at a well-defined pressure. The Sample System design will depend on the application. Generally, it consists of the mounted Transmitter, a sample gas inlet, flow regulating valve, flow meter, and calibration gas inlet valves.

The Sample System may also include a pressure gauge/regulator, pump, aspirator, coalescer/filter, or other components. Figure 1-2 below is an illustration of a Sample System which includes most of the components described above.

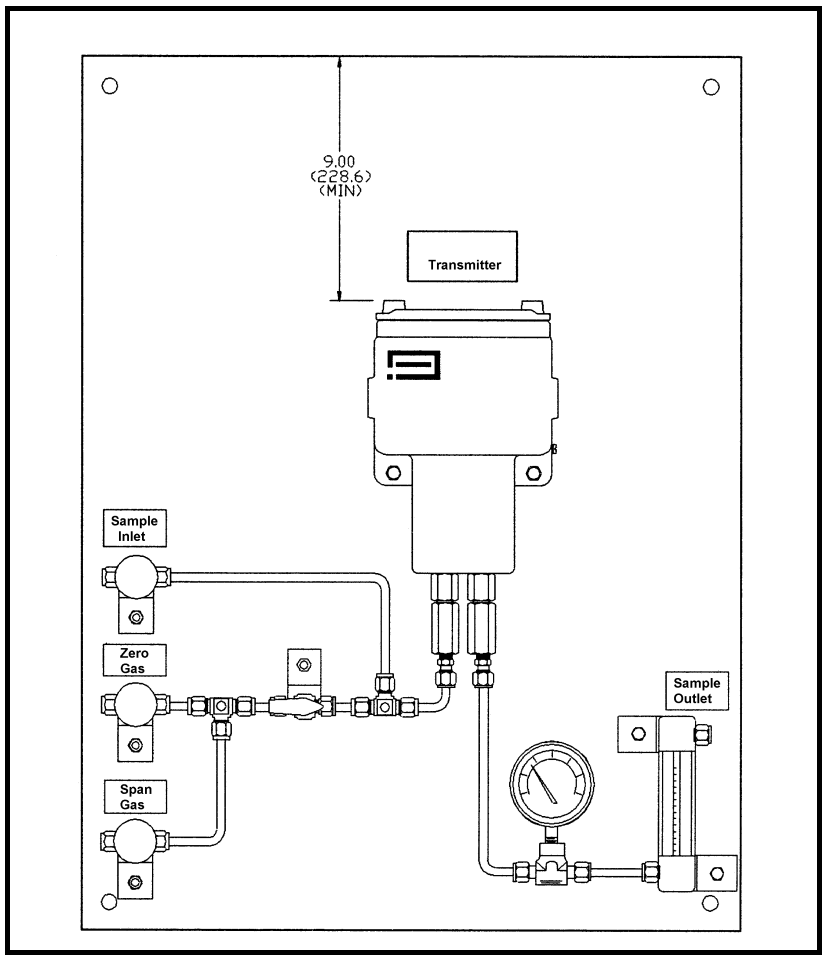

Figure 1-2: A TMO2 Sample System

System Operation

The TMO2 Transmitter uses the thermoparamagnetic ("magnetic wind") principle to measure oxygen concentration in gases (see Appendix A for "magnetic wind" theory).

During operation, the TMO2 Transmitter generates an electrical signal proportional to oxygen concentration, and (optionally) one additional signal for either background gas or pressure compensation.

The TMO2D Electronics Display accepts the oxygen and compensation signals from the Transmitter and, using transmitter calibration, background gas compensation, and pressure compensation data, calculates oxygen concentration and displays it as a percentage of the sample (see Figure 1-3 below).

Note: *The TMO2D milliamp output range can be independent of the Display range.*

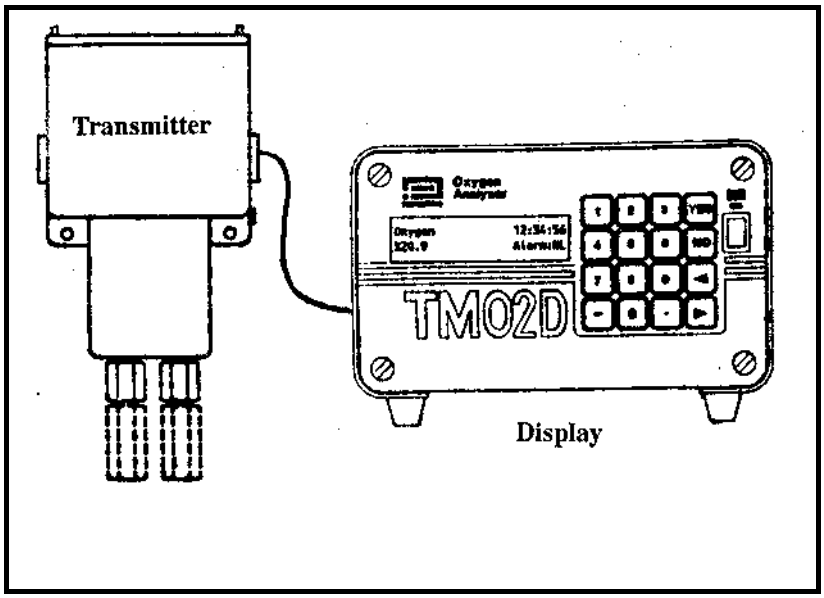

Figure 1-3: TMO2 Transmitter and TMO2D Display

Chapter 2

Installation

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Mounting the TMO2 Sample System 2-3

Mounting the TMO2D Electronic Display 2-4

Making Wiring Connections 2-5

Introduction

This section provides information on how to mount and wire the Transmitter and Display. Read this section if you are installing the TMO2D for the first time. A typical TMO2D installation consists of the following:

- Mounting the TMO2 Transmitter
- Mounting the TMO2 Sample System
- Mounting the TMO2D Electronic Display
- Wiring the Transmitter to the Display
- Wiring Recorders, AutoCal System, Alarms, etc.
- Connecting Power

Caution!

The interconnecting wiring between the transmitter and display must be completed before powering up.

!WARNING!

TO ENSURE THE SAFE OPERATION OF THE TMO2D, YOU MUST INSTALL AND OPERATE IT AS DESCRIBED IN THIS MANUAL. IN ADDITION, BE SURE TO FOLLOW ALL APPLICABLE SAFETY CODES AND REGULATIONS FOR INSTALLING ELECTRICAL EQUIPMENT IN YOUR AREA.

ALL INSTALLATION PROCEDURES SHOULD BE PERFORMED BY TRAINED SERVICE PERSONNEL.

Mounting the TMO2 Transmitter

The TMO2 Transmitter is shown in Figure 2-1 below. For optimum response, mount it as close as possible to the process being monitored (preferably within 5 feet (1.52 meters)). Be sure to keep the Transmitter level to within 15° of vertical and provide at least 9 inches of clearance above the top cover of the Transmitter to allow access to the printed circuit board (PC Board) for calibration and maintenance.

Note: *Be sure to have the correct certified configuration if the Transmitter is mounted in a hazardous area. Ambient temperature must be -20°C to 40°C (-4° to 104°F).*

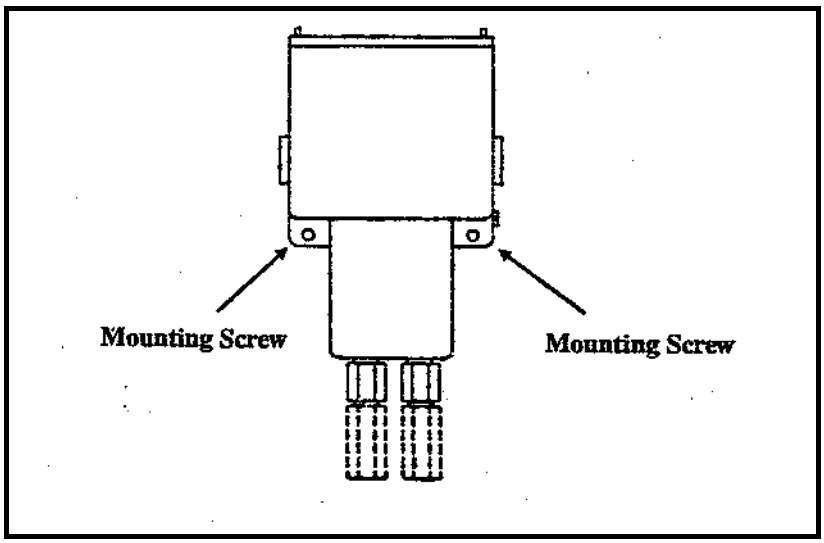


Figure 2-1: The TMO2 Transmitter in Mounted Position

Mounting the TMO2 Sample System

A complete Sample System includes the Transmitter and associated sample tubing and components already mounted to a metal panel. Figure 2-2 below shows a Sample System which includes calibration gas inlet valves, filter/coalescer with drain valve, pressure regulator and bypass flowmeter in addition to the mandatory sample flow meter and flow regulating valve.

Mount the TMO2 Sample System as close to the process as possible. Once the Sample System is mounted, connect the oxygen sample input and output lines via the 1/4" tube fittings at the bottom of the Transmitter.

The sample line is generally recommended to be 1/4" stainless steel tube and 1/4" stainless steel tube fittings. Attempt to minimize the sample line length. Similarly connect calibration gas inlets, sample outlets, bypass outlet, and filter/coalescer drain as applicable.

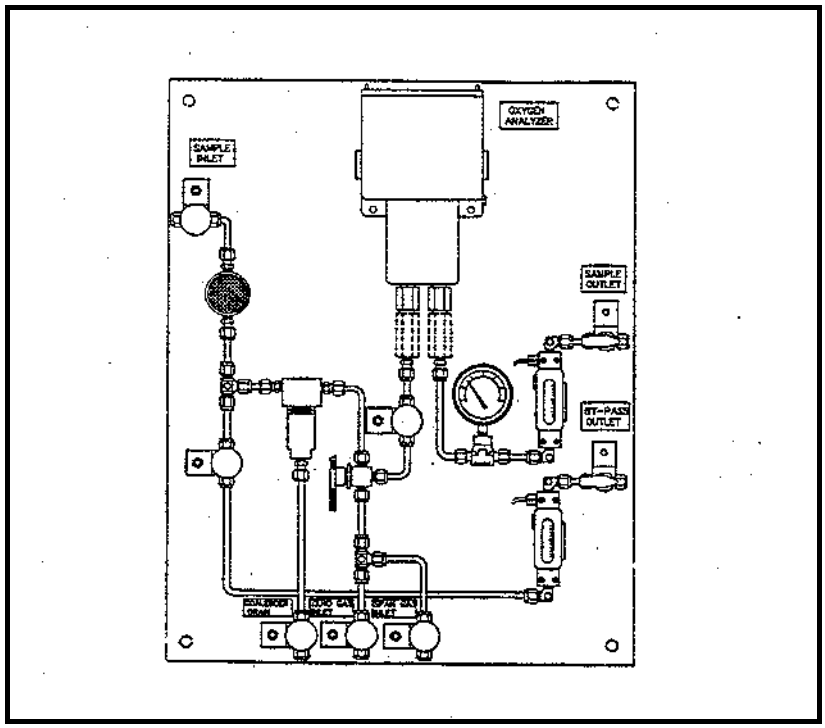


Figure 2-2: A Mounted TMO2 Sample System

Mounting the TMO2D Electronic Display

The Electronic Display comes in four mounting configurations: bench, rack, panel, and weatherproof mount (see Appendix B for mounting dimensions).

No special mounting requirements are needed for the Display. If you have a bench mount, simply put the Display in a convenient location, connect the wires from the Transmitter, and connect the power. If you have a rack or panel mount, insert the Display into the rack or panel, connect the wires from the Transmitter, and connect the power. The weatherproof model can be similarly mounted.

Note: *The power cord is the main disconnect device.*

IMPORTANT: *To comply with the European Low Voltage Directive, you must install a switch or circuit breaker on the input power line. For greatest safety, locate the circuit breaker or switch near the unit that the line serves.*

Making Wiring Connections

Normally, a 3- or 4-wire, color-coded cable is supplied to connect the Transmitter to the Display.

First make wiring connections from Terminal Block 1 (TB1) pins 1-4 on the Transmitter PC Board to the OXYGEN CELL Terminal Block located on the rear panel of the Display.

!ATTENTION EUROPEAN CUSTOMERS!
IN ORDER TO MEET CE MARK REQUIREMENTS, YOU MUST SHIELD AND GROUND ELECTRICAL CABLES AS DESCRIBED IN APPENDIX F.

Wiring the Transmitter to the Display

Remove the Transmitter cover by loosening the set screw and unscrewing the cover. The Transmitter PC board is located directly beneath (see Figure 2-3 below).

Note: *There is a "1" printed on the PC Board next to the #1 pin connection on TB1.*

1. Route the cable into the Transmitter through one of the 3/4" conduit holes on the side of the Transmitter.

2. Unplug TB1 on the Transmitter PC Board by carefully pulling it directly up without bending the pins attached to the board.

3. Loosen the TB1 sidescrews and insert the colored wires into the corresponding openings on top of TB1 (see Table 2-1 on page 2-7 for color-coded pin connections).

4. Tighten the sidescrews and carefully plug TB1 back onto the PC Board.

5. Similarly connect the cable to the OXYGEN CELL Terminal Block located on the rear panel of the Display (see Table 2-1 for color-coded pin connections).

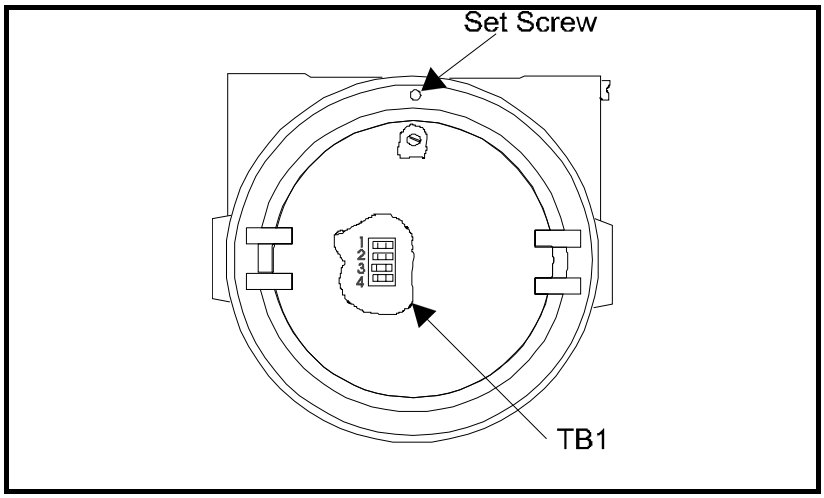


Figure 2-3: Top View of Transmitter PCB and TB1

= Protective Conductor Terminal

Wiring the Transmitter to the Display (cont.)

Table 2-1: Transmitter to Display Wiring Pin Connections

Wire Connections	Transmitter Terminal Block	Display Terminal Block
Power +24VDC **Red**	Pin 1	Pin 1
Power Return **Black**	Pin 2	Pin 2
Oxygen **White**	Pin 3	Pin 3
Compensation **Blue or Green**	Pin 4	Pin 4

!WARNING!
BE SURE TO PLUG UP THE UNUSED CONDUIT HOLE ON THE SIDE OF THE TRANSMITTER TO MAINTAIN THE APPROPRIATE WEATHERPROOF OR EXPLOSION-PROOF RATING.

Note: *Refer to Figure 2-4 on the following page for a detailed description of all wiring connections.*

Wiring Recorders, AutoCal System, Alarms, etc.

Optionally, the TMO2D can be wired to Recorders, AutoCal, and Alarms. Figure 2-4 below diagrams all possible wiring connections.

Table 2-2: Maximum Cable T(*)N4 Lengths and Gauges

Length	AWG
300’	22
500’	20
800’	18
1250’	16
2000’	14
3125’	12

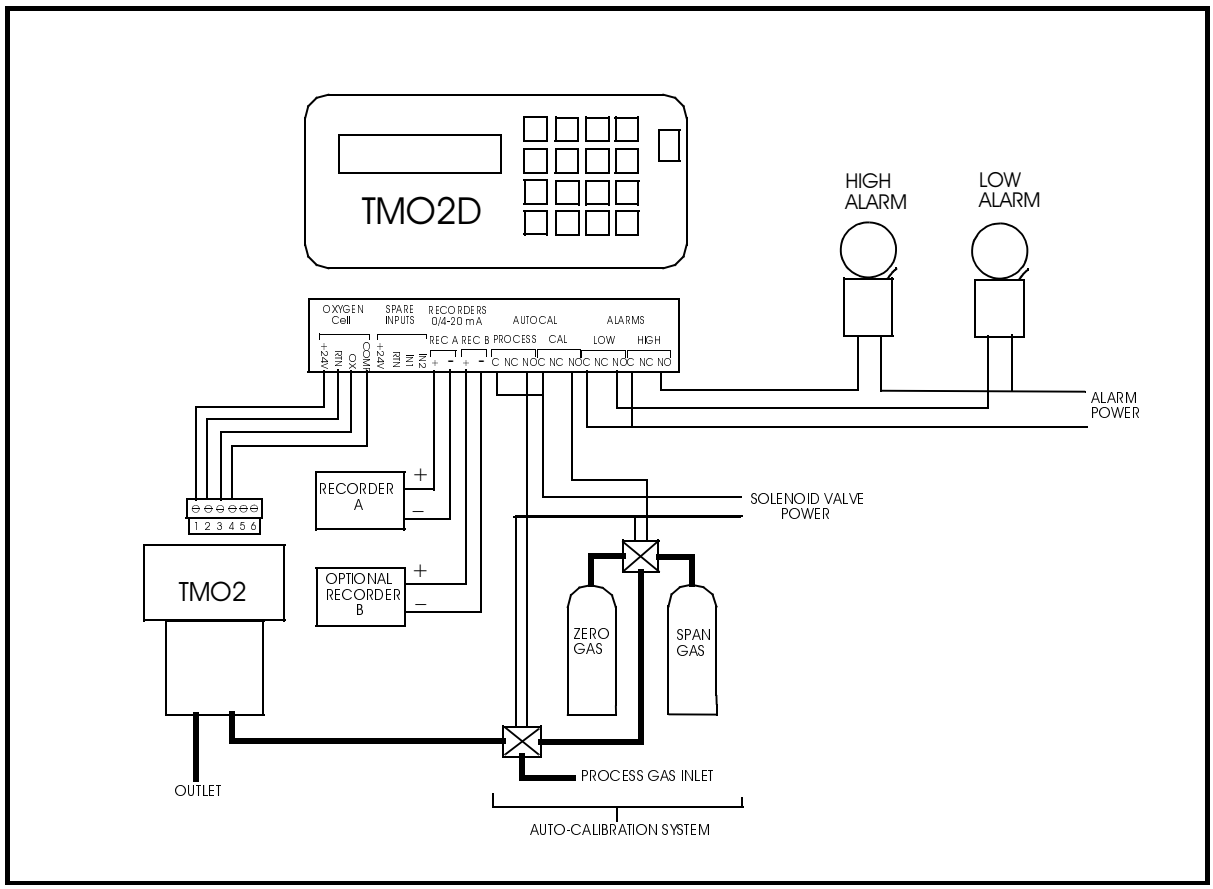


Figure 2-4: All Transmitter and Display Wiring Options

RS-232C Serial Port

The TMO2D also contains a bidirectional, industry standard RS-232C serial port (#J8), which can be connected to a terminal or computer that supports the RS-232C protocol. (See Figure 2-5 below for RS-232 wiring pin connections; see Appendix C for a corresponding key chart.)

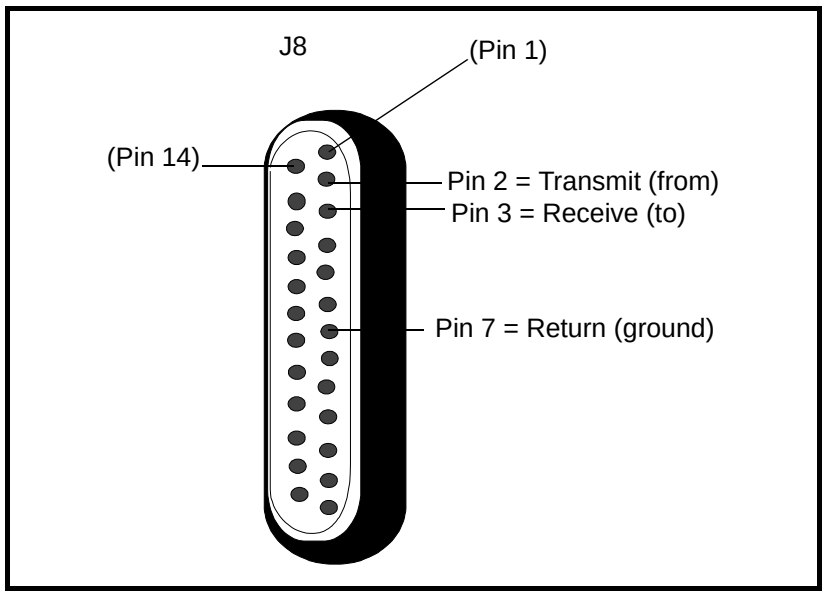


Figure 2-5: Display RS-232C Serial Port Connections

Connecting Power

Once you have mounted and connected the Transmitter and Display, and (if applicable) wired recorders, alarms, etc., connect the Display to one of the following power supplies:

- Japan, 100 VAC
- U.S., 110/120 VAC
- Europe, 220 VAC
- Australia, 240 VAC

Caution!
The interconnecting wiring between the Transmitter and Display must be completed before powering up.

Note: *The power cord is the main disconnect device.*

IMPORTANT: *To comply with the European Low Voltage Directive, you must install a switch or circuit breaker on the input power line. For greatest safety, locate the circuit breaker or switch near the unit that the line serves.*

= Protective Conductor Terminal

Chapter 3

Operation

Introduction 3-1

Powering Up the TMO2D 3-1

Establishing Gas Flow 3-1

Operating the Display 3-1

The LCD Display 3-2

The Keypad 3-2

Introduction

Once the TMO2D has been installed, the analyzer must be powered up and a gas flow must be established before operating the analyzer via the Electronics Display.

This section covers the following:

- Powering Up The Transmitter
- Establishing Gas Flow
- Operating The Electronic Display

Powering Up the TMO2D

The Transmitter has no power switch and will begin operating once it has been connected to the Display and the power has been turned on. Allow 90 minutes after power is turned on for the Transmitter to warm-up and stabilize. During this time, establish gas flow through the system.

Establishing Gas Flow

Open the necessary valves to establish the flow at 1.0 ±0.2 SCFH (500 ±100 cc/min). Make sure that nothing impedes the flow of gas thereby causing a pressure or vacuum buildup within the Transmitter. For proper operation the Transmitter should be vented to the atmosphere.

Note: *The Transmitter has been calibrated at atmospheric pressure. Unless pressure compensation is being used, operating the Transmitter at other pressures will cause erroneous readings.*

Operating the Display

The Electronic Display unit contains a 2-line by 24-character backlit Liquid Crystal Display screen (LCD). On power-up, the Display unit tests its memory (RAM) then searches for valid calibration data from the Display as well as input from the TMO2 Transmitter.

If calibration data has already been entered into the Display, the unit immediately begins taking measurements from the Transmitter and the LCD begins displaying percent oxygen concentration.

If valid calibration data has not been entered and stored in the Display, or if the the Transmitter is not hooked up to the Display, the LCD will display erroneous readings. (Proceed to Chapter 4, page 4-1, to enter data into the Display.)

The LCD Display

The TMO2D is operated via the Display keypad. In order to facilitate operation, it is important to familiarize yourself with the Display and keypad functions

The first line of the LCD screen displays the current measurement source or menu title and a real-time clock. The second line of the LCD screen displays the measured data on the left and the current alarm condition on the right (see Figure 3-1 below).

Note: *The LCD contains an electroluminescent (EL) panel to enhance readability of the screen during operation. To activate the EL panel, press any key except the NO key.*

The Keypad

For operational purposes, the keypad (Figure 3-1 below) contains the digits 0-9, a minus sign, a decimal point, and four special operations keys:

- YES
- NO
- Left Arrow
- Right Arrow

Note: *For details on how to use the keypad to program the Display, refer to Chapter 4.*

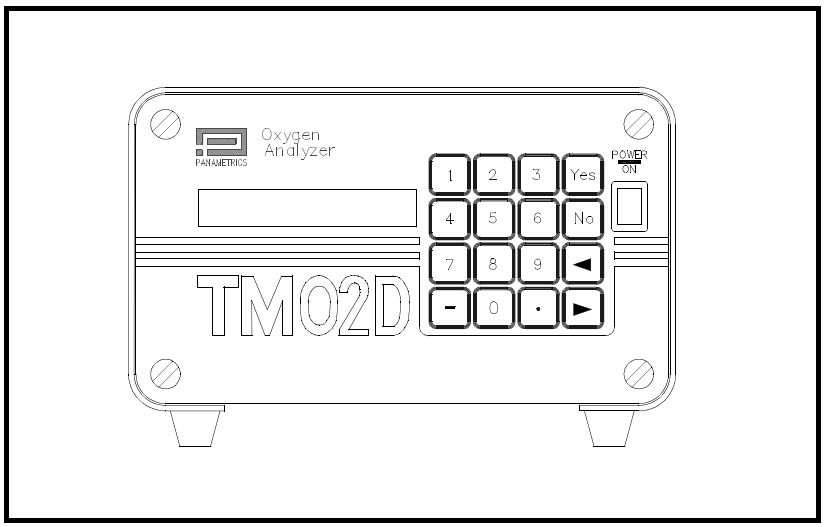


Figure 3-1: TMO2D Display and Keypad

Chapter 4

Programming the TMO2D

Introduction 4-1

Entering Data into the User Program 4-1

Programming the TMO2D via the Display 4-2

The Setup Menu 4-4

The Recorder Menu 4-9

The Alarm Menu 4-11

The Tests Menu 4-13

The Calibration Menu 4-17

Introduction

The TMO2D contains an interactive user-friendly program that allows the user to change operating parameters as desired.

The user program has six main menus. Use the front panel keypad and display to check or change the current operating parameter settings. Data is stored in memory and is retained for several years, even if the main power is lost. New data overrides any previously entered data.

The user program consists of the following six main menus:

- Setup
- Recorders
- Alarms
- Test
- Calibration
- Resume

Entering Data into the User Program

To enter data into the user program or to check previously entered values, enter the Menu Mode. When power is turned on, the TMO2D is in the Operate Mode. To enter the Menu Mode:

1. Press the NO key.

2. Key in the code 1 2 3. The TMO2D will display an asterisk (*) after each digit is entered.

The LCD screen now displays the Setup Menu, the first of the six main menus. At this display press YES to enter this menu, or NO to go on. Pressing NO continuously scrolls through all six main menus.

Note: *The first five options are main menus, the "RESUME" prompt is used to exit the Menu Mode and return to Operate Mode.*

If an incorrect code is entered or a non-numeric (YES/NO or arrow) key is pressed rather than 1 2 3, the LCD will automatically resume displaying data, and the user must press NO to re-attempt the code. Once all three digits have been entered correctly, the Display will cease collecting data and the LCD will switch to Menu Mode.

Key Functions

The YES key is used to confirm numeric entries or to select a displayed menu option.

The NO key is used to clear a numeric entry or to scroll forward through the menu options.

The Left Arrow key has two functions:

- It is used as a backspace key during numeric entry. The right most digit of the entry will be erased for each press of the left arrow.
- It is used to step backward through a list of menu options.

The Right Arrow key is used to scroll forward through the menu options. It is equivalent to pressing the NO key in the Menu Mode.

Programming the TMO2D via the Display

This section gives a brief explanation of Display and menu navigation and then takes you through the programming procedure.

Display Navigation

On power-up, the first line of the LCD screen contains the current measurement source and a real-time clock. The second line of the LCD contains the measured data on the left and the current alarm condition on the right (see Figure 4-1 below).

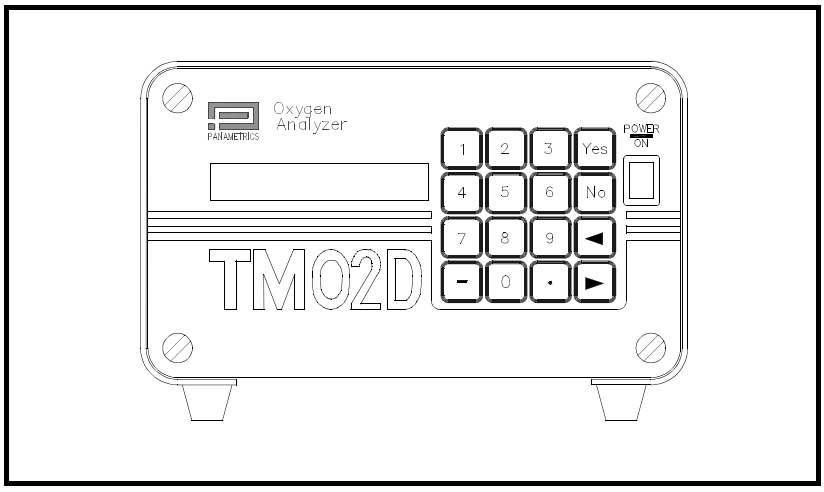


Figure 4-1: TMO2 Display and Keypad

While displaying oxygen concentration, the Display will ignore all keys except the NO key. On receipt of a NO, the LCD will begin displaying “Enter Code:” and await the program entry code, 1 2 3. During code entry the Display continues to update the data display, alarm status, and recorder ouput.

Menu Navigation

After the passcode 1 2 3 is entered, the LCD switches to Menu Mode, which allows programming of the Display, i.e., setting parameters and calibration data, performing alarm and recorder tests. While in Menu Mode, data collection is suspended and alarm status and recorder outputs hold their current values.

In Menu Mode, the first line of the LCD shows the title of the current menu in capital letters. The second line displays the current menu options.

The two types of response keys available in the Menu Mode are YES/NO and Selector keys. Pressing YES selects the displayed option. Pressing NO skips that option and displays the next option in the list. The Selector option is used to choose between two or three possible choices in the menu.

Note: *The menu lists are circular, i.e., skipping over the last option in the list returns to the first option in the list.*

The following sections describe the programming procedure and menu navigation in detail one menu at a time. (Also refer to Appendix E for flow diagrams of each menu.)

The Setup Menu

The first Main Menu is the Setup Menu. The Setup Menu contains the following six submenus:

- Set Time
- Set Date
- Set Backlight
- Set Display
- Set Communications
- Done

These submenus allow the user to alter operating parameters. Once entered, these values will remain in the Display memory until they are changed. (Refer to Appendix E for a flow diagram of the Setup Menu.)

Set Time?

The first display in the Setup Menu is "Set Time?," which sets the current time in 24-hour format. For example, to enter 1:15 pm (13.15 in 24-hour time):

MAIN MENU Setup?	Press YES to enter the Setup Menu.
SETUP MENU Set Time?	Press YES to set the time.
Enter 24 hour time: HH.MM [XX.XX]: 13.15	Then use the numeric keys to enter a 1, 3, **.** , 1 and 5. (The X's represent the previous time entered.)
Enter 24 hour time: HH.MM [13.15]:	Press YES to confirm the entry. Press YES again to exit.
SETUP MENU Set Time?	Press NO to proceed to the next submenu.

Set Date?

The Set Date submenu is used to set the current date in USA (month, day, year) format. For example, to enter February 24, 1991:

SETUP MENU Set Date?	Press YES to set the date.
Enter Date (MM.DD.YY): [XX.XX.XX]:2.24.91	Then use the numeric keys to enter a 2, 24, and 91. (The X's represent the previous date entered.)
Enter Date (MM.DD.YY): 2.24.91	Press YES to confirm the entry.
SETUP MENU Set Date?	Press YES again to exit.
SETUP MENU Set Backlight?	Press NO to proceed to the next submenu.

Set Backlight?

The LCD contains an electroluminescent (EL) panel to enhance the readability of the screen in dim light. EL panels have a finite life span, dimming with use. To maintain the life of the EL backlight, the Display will automatically turn the backlight off after a predetermined time period. The Backlight time-out period can be set from 0 (never on) to 60 minutes. The default timeout is 3 minutes. For example, to set this time to 10 minutes:

SETUP MENU Set Backlight?	Press YES to set the backlight.
SETUP MENU Remain ON (min) [X]: 10	Then use the numeric keys to enter 10. (The X's represent the previous time entered.)
SETUP MENU Remain ON (min) [10]:	Press YES to confirm the entry.
SETUP MENU Set Backlight?	Press YES again to exit.
SETUP MENU Set Display?	Press NO to proceed to the next submenu.

Set Display?

In order for a compensation value to be displayed, either background or pressure compensation must be enabled through the Calibration: Edit Calibration Data Menu (see page 4-30). If neither pressure nor background compensation is enabled, a “Comp not enabled” message will be displayed.

SETUP MENU Set Display?	Press YES to set the display.
Display Compensation [YES] no	Then use the NO or arrow keys to move the brackets to the desired entry.
SETUP MENU Set Display?	Press YES to confirm the entry and exit.
SETUP MENU Set Communications?	Press NO to proceed to the next submenu.

Set Communications?

The Set Communications submenu has two choices: (1) Baud Rate, and (2) Update Rate.

Baud Rate: The Display contains a bi-directional, industry standard RS-232C serial port that allows operation of the instrument remotely with a terminal or computer that supports the RS-232C protocol. All keypad operations and most display operations can be performed remotely via this port.

The Display supports the communication rates of 9600, 4800, 2400, 1200, and 300 baud. The default setting is 9600 baud. Word size is fixed at 8 bits, 1 stop bit, no parity.

Note: *300 baud is provided for compatibility with older equipment; however, the use of 300 baud greatly limits the computation speed of the TMO2D, and its use is not recommended.*

Set Communications? (cont.)

The Set Communications submenu is used to set a baud rate and an update rate.

SETUP MENU Set Communications?	Press YES to enter the Set Communications submenu.
SET COMMUNICATIONS Set Baud Rate?	Press YES to enter the baud rate.
SELECT BAUD RATE 9600 baud?	Use the NO or arrow keys to scroll through the choices.
SELECT BAUD RATE 4800 baud?	
SELECT BAUD RATE 2400 baud?	
SELECT BAUD RATE 1200 baud?	
SELECT BAUD RATE 300 baud?	Press YES to select the desired baud rate and exit.
SET COMMUNICATIONS Set Baud Rate?	Press NO to proceed to the next submenu.

Note: *The baud rate can be changed via a terminal connected to the RS-232C port. However, this is not recommended, as the TMO2D will immediately change to the new baud rate. Display and keyboard operation will not be correct until the baud rate of the terminal is changed to match the new baud rate set in the TMO2D.*

SET COMMUNICATIONS Set Update Rate?	Press YES to set the update rate.

Set Communications? (cont.)

Update Rate: This option is used to change the interval at which data goes to the serial port. The current data interval will appear in brackets, and users can enter a new data interval.

Data intervals range from 0 to 300 seconds. A data rate of zero will prevent data from passing to the serial port.

SET COMMUNICATIONS Set Update Rate?	Press YES to set the update rate.
SET COMMUNICATIONS Data Interval [X]: 180	For example, enter 1, 8 and 0 for a 180 sec (3 min) interval. (The X represents the previously entered data interval.).
SET COMMUNICATIONS Data Interval [180]:	Press YES to confirm the entry.
SET COMMUNICATIONS Set Update Rate?	Press YES again to exit.
SET COMMUNICATIONS Done?	Press NO to proceed to the next submenu.
SETUP MENU Set Communications?	Press YES to exit.
SETUP MENU Done?	Press NO to proceed to the next submenu.
MAIN MENU Setup?	Press YES to exit.

This completes the Setup Menu. Press NO to proceed to the next Main Menu title.

The Recorder Menu

The second Main Menu is the Recorder Menu. The Recorder Menu is used to select which recorder (A or B) to adjust, and allows entry of all necessary information for that recorder.

The TMO2D provides a choice of one non-isolated 0/4-20 mA recorder output, or two isolated 0/4-20 mA recorder outputs. Both recorder options can be set for a 0-20 mA or a 4-20 mA response. Output can be scaled anywhere within the range of the transmitter.

Note: *The Display is programmed to accept settings for two recorders; however, if only a single, non-isolated recorder output is used, only recorder A is effective.*

Use the steps in the following example to set up recorders. We will set recorder A for a 0-20 mA output, with 0 mA equal to 0% oxygen and 20 mA equal to 100% oxygen. (Refer to Appendix E for a flow diagram of the Recorder Menu.)

MAIN MENU Setup?	At this prompt, press NO until the Recorder Menu displays.
MAIN MENU Recorders?	Press YES to enter the Recorder Menu.
Select Recorder to set: [A] B done	Use the NO or arrow keys to move the brackets to “A,” and press YES to confirm the selection.
Rcd A Output (mA): [0-20] 4-20	Use the NO or arrow keys to select the desired recorder range..
Recorder A 0 mA Value $\%O_2$ [X.XX]:	Press YES to set the low end value. (The X’s represent the previously entered value for 0 mA.)
Recorder A 0 mA Value $\%O_2$ [0.00]:	Use the numeric keys to enter a 0, ., 0, and 0, then press YES to confirm the entry.

The Recorder Menu (cont.)

Recorder A 20 mA Value $\%O_2$ [X.XX]:	Press YES again to proceed to the high end value. (The X's represent the previously entered value for 20 mA.)
Recorder A 20 mA Value $\%O_2$ [100.0]:	Use the numeric keys to enter a 1, 0, 0, ., and 0, then press YES to confirm the entry.
Select Recorder to set: [A] B done	Press YES to exit.

Recorder B is programmed the same way. After entering the necessary values:

Select Recorder to set: A B [DONE]	Use the NO or arrow keys to select "DONE."
MAIN MENU Recorders?	Press YES to exit.

This completes the Recorder Menu. Press NO to proceed to the next Main Menu title.

The Alarm Menu

The third Main Menu is the Alarm Menu. The TMO2D is provided with two four-pole double throw relays for use in activating alarm devices. Both relays provide a normally-open and a normally-closed set of contacts. The alarms are addressed as HIGH and LOW. The HIGH alarm relay will trip when the current reading is greater than or equal to the high alarm setpoint. The LOW alarm relay will trip when the current reading is less than or equal to the low alarm setpoint.

Use the steps in the following example to set the high alarm setpoint to 75% O_2 and the low alarm setpoint to 25% O_2. (Refer to Appendix E for a flow diagram of the Alarm Menu.)

MAIN MENU Setup?	At this prompt, press NO until the Alarm Menu displays.
MAIN MENU Alarms?	Press YES to enter the Alarm Menu.
Select Alarm to set: [HIGH] low done	Use the NO or arrow keys to select "HIGH."
Enter Alarm Setpoint: High %O_2 [X.XX]:	Press YES to enter the high alarm setpoint. (The X's represent the previously entered setpoint.)
Enter Alarm Setpoint: High %O_2 [75.0]:	Use the numeric keys to enter 7 and 5, then press YES twice to confirm the entry and proceed to the next prompt.
Select Alarm to set: high [LOW] done	Use the NO or arrow keys to select "LOW."
Enter Alarm Setpoint: Low %O_2 [X.XX]:	Press YES to enter the low alarm setpoint. (The X's represent the previously entered setpoint.)

The Alarms Menu (cont.)

Enter Alarm Setpoint: Low %O_2 [25.0]:	Use the numeric keys to enter 2 and 5, then press YES twice to confirm the entry and proceed to the next prompt.
Select Alarm to set: high low [DONE]	Use the NO or arrow keys to select "DONE."
MAIN MENU Alarms?	Press YES to exit.

This completes the Alarms Menu. Press NO to proceed to the next Main Menu title.

The Tests Menu

The fourth Main Menu is the Tests Menu. The Tests Menu provides assistance in installing and troubleshooting the TMO2D.

The Tests Menu contains the following four submenus:

- DVM Test
- Recorder Calibrate Test
- Alarms Test
- Done

(Refer to Appendix E for a flow diagram of the Tests Menu.)

DVM Test

The DVM test allows the Display to operate as a simple digital voltmeter to measure, in milliamps, the Transmitter's oxygen and compensation signals. The Display is updated approximately twenty times per second, facilitating connection and calibration of the Transmitter.

Follow the steps below to test the oxygen signal input from the Transmitter.

MAIN MENU Setup?	At this prompt, press NO until the Test Menu displays.
MAIN MENU Tests?	Press YES to enter the Test Menu.
Tests DVM Test?	Press YES to select the DVM submenu.
Select DVM Input: [GAS] comp done	Use the NO or arrow keys to select the "GAS" input.
O2 DVM TEST X.XX mA	Press YES to confirm the entry. (The X's represent the milliamp signal, which will update continuously until any key is pressed.)

DVM Test (cont.)

The compensation signal input is displayed the same way.

Select DVM Input: [GAS] comp done	Use the NO or arrow keys to select "DONE."
TESTS DVM Test?	Press YES to exit.
TESTS Recorder Calibrate?	Press NO to proceed to the next submenu.

Recorder Calibrate Test

The Recorder Calibrate Test allows a $\%O_2$ to be output to the recorder to facilitate adjustment of the recording device's zero and span.

For example, to enter a $\%O_2$ of 36.39 to be output to recorder A:

TESTS Recorder Calibrate?	Press YES to select the Recorder Calibrate Test.
Select Recorder to test: [A] B done	Use the NO or arrow keys to select "A."
Set Recorder A to: $\%O_2$ [XX.XX]:	Press YES to confirm your selection. (The X's represent the previously entered setpoint.)
Set Recorder A to: $\%O_2$ [36.39]:	Use the numeric keys to enter 3, 6, ., 3, and 9, then press YES twice to confirm the entry and proceed to the next prompt.
Select Recorder to test: A B [DONE]	Use the NO or arrow keys to select "DONE."
TESTS Recorder Calibrate?	Press YES to exit.
TESTS Alarms Test?	Press NO to proceed to the next submenu.

Alarms Test

The Alarms Test trips and resets the alarm relays via the keypad in order to test the operation of external alarm devices.

For example, to test the high alarm relay:

TESTS Alarms Test?	Press YES to select the Alarms Test.
Select Alarm to test: [HIGH] low done	Use the NO or arrow keys to select "HIGH."
Turn High Alarm: [ON] off done	Press YES to confirm your selection, then use the NO or arrow keys to select "ON."
Turn High Alarm: on OFF done	Press YES to confirm the ON selection/

Note: *Upon selecting the ON option and pressing YES, the High Alarm relay will turn on, and the selection brackets will skip to OFF.*

Turn High Alarm: [ON] off done	Press YES to turn the high alarm off.

Note: *Upon selecting the OFF option and pressing YES, the High Alarm relay will turn off, and the selection brackets will skip to ON.*

Turn High Alarm: on off [DONE]	Use the NO or arrow keys to select "DONE."
Select Alarm to test: high low [DONE]	Press YES to confirm the selection, then use the NO or arrow keys to select "DONE" again.

Alarms Test (cont.)

TESTS Alarms Test?	Press YES to confirm the selection and exit.
TESTS Done?	Press NO to exit the submenu.
MAIN MENU Done?	Press YES to exit the Tests Menu.

This completes the Tests Menu. Press NO to proceed to the next Main Menu title.

The Calibration Menu

The fifth Main Menu is the Calibration Menu. The Calibration Menu is used to enter measurement parameters and calibration data into the TMO2D.

The Calibration Menu contains the following three submenus:

- Auto Cal Parameters
- Edit Calibration Data
- Done

(Refer to Appendix E for a flow diagram of the Calibration Menu.)

Auto Cal Parameters?

The Display can be programmed to perform an automatic calibration procedure (Auto Cal) at specified time intervals ranging from minutes to months.

By performing measurements on two calibration gases (zero and span), the Display can correct for changes in the response of the Transmitter without operator intervention.

At the specified time interval, the Display activates a solenoid controlled valve on an optional sampling system. This isolates the Transmitter from the process stream and connects the Transmitter to the span calibration gas. After a programmable settling time, during which the span gas replaces the process gas, measurements are taken of the span calibration gas.

The Display then activates a second solenoid valve to connect the Transmitter to the zero calibration gas. The Transmitter then settles as the zero gas replaces the span gas, and measurements are taken of the zero calibration gas.

After taking span and zero gas measurements, the Display reconnects the Transmitter to the process stream. Then a final settling time takes place while the process gas replaces the zero gas.

Once settling has been completed, if no error has occurred, the Display calculates the amount of drift and applies the calculated drift to the factory oxygen calibration data. The factory calibration data is not changed. The corrections to the calibration data are stored as the Drift Curve.

If the Auto Cal measurements were out of range, the data is disregarded and the Display uses the drift curve already stored in memory. If Auto Cal Error Handling is enabled, the screen, alarms, and recorders will respond as programmed.

Auto Cal Parameters? (cont.)

Note: *Auto Calibration requires the Auto Cal option to be ordered with the TMO2D. Auto Cal also requires a sampling system with solenoid valves, and two distinct calibration gases (or one calibration gas and air). Using the Auto Cal procedure without these options will produce an erroneous calibration and prevent proper operation of the TMO2D.*

Follow the steps below to enter the Auto Cal Parameters submenu.

MAIN MENU Setup?	At this prompt, press NO until the Calibration Menu displays.
MAIN MENU Calibration?	Press YES to enter the Calibration Menu.
CALIBRATION MENU Auto Cal Parameters?	Press YES to select the Auto Cal Parameters submenu.
AUTO CALIBRATION MENU Set Time Interval?	Then use the NO or arrow keys to view the eight options within this submenu.
AUTO CALIBRATION MENU Set Zero Gas?	
AUTO CALIBRATION MENU Set Span Gas?	
AUTO CALIBRATION MENU Set Settling Time?	
AUTO CALIBRATION MENU Perform AutoCal?	
AUTO CALIBRATION MENU Zero AutoCal?	
AUTO CALIBRATION MENU View Drift Curve?	
AUTO CALIBRATION MENU Done?	

Auto Cal Parameters? (cont.)

The Auto Cal options are described individually in the following sections.

Set Time Interval?

The Set Time Interval option is used to set the time interval at which an Auto Cal will occur.

Pressing YES at the “Set Time Interval?” prompt provides the option of selecting an interval of either hours or days.

Hours can be entered fractionally, i.e., 90 minutes = 1.5 hours, up to a maximum of 24. An interval of zero hours prevents Auto Cal from occurring.

Days can range from 0 to 99. Fractional days are not permitted. An interval of zero days prevents Auto Cal from occurring. If a non-zero number of days is entered, the Display will prompt for the time of day when the Auto Cal should occur.

For example, to set the time interval for 12 hours:

AUTO CALIBRATION MENU Set Time Interval?	Scroll to the Set Time Interval option, then press YES.
Select AutoCal Interval: [HOURS] days	Use the NO or arrow keys to select “HOURS.”
Auto-Cal Interval: Hours [XX.XX]:	Press YES to enter the number of hours. (The X’s represent the previously entered hours.)
Auto-Cal Interval: Hours [12.00]:	Use the numeric keys to enter a 1 and 2, then press YES to confirm the entry.

To set the time interval for 3 days:

AUTO CALIBRATION MENU Set Time Interval?	Press YES twice to re-enter the Set Time Interval submenu.
Select AutoCal Interval: hours [DAYS]	Use the NO or arrow keys to select “DAYS.”

Set Time Interval? (cont.)

Auto-Cal Interval: Days [X]:	Press YES to enter the number of days. (The X's represent the previously entered days.)
Auto-Cal Interval: Days [3]:	Use the numeric keys to enter a 3, then press YES twice to confirm the entry and proceed to the next option.

Now enter a time of day at which Auto Cal will occur. Enter the time in 24-hour format.

For example, set the Auto Cal to occur at 1:45 P.M. (13.45 in 24-hour time).

Auto-Cal at Time: HH.MM [13.45]:	Use the numeric keys to enter a 1, 3, ., 4, and 5 (1:45 pm), then press YES to confirm the entry.
AUTO CALIBRATION MENU Set Time Interval?	Press YES again to exit.
AUTO CALIBRATION MENU Set Zero Gas?	Press NO to proceed to the next option.

Set Zero Gas?

The Set Zero Gas option is used to enter the oxygen concentration and the equilibration time for the zero gas.

If 100% nitrogen is used for the zero gas, the concentration would be zero. If a mixture is used, the oxygen concentration of the mixture should be entered. The default concentration is 0% oxygen.

After entering the O_2 concentration, the display will automatically prompt for the equilibration time for the zero gas. The equilibration time should allow for the distance the calibration gas must travel, and for the settling time of the Transmitter cell.

Note: *For a successful auto calibration to be performed, the equilibration time should be at least 3 minutes. The default is 5 minutes. For testing purposes, the equilibration time can be as low as 10 seconds. The maximum equilibration time is 30 minutes.*

For example, set the zero gas for 100% nitrogen for an equilibration time of 3 minutes.

AUTO CALIBRATION MENU Set Zero Gas?	Press YES to enter the Set Zero Gas option.
Zero Gas %O_2 [X.XX]:	(The X's represent the previously entered oxygen concentration.)
Zero Gas %O_2 [0.00]:	Use numeric keys to enter a 0, then press YES twice to confirm the entry and proceed to the next option.
Zero Gas ON for MM.SS [X.XX]:	(The X's represent the previously entered equilibration time.)

Set Zero Gas? (cont.)

Zero Gas ON for MM.SS [3.00]:	Enter the equilibration time (in this case a 3 for 3 minutes), then press YES to confirm the entry.
AUTO CALIBRATION MENU Set Zero Gas?	Press YES to exit.
AUTO CALIBRATION MENU Set Span Gas?	Press NO to proceed to the next option.

Set Span Gas?

The Set Span Gas option is used to enter the oxygen concentration and the equilibration time for the span gas. The default concentration for the Span Gas is 20.93%, the concentration of oxygen in air.

The procedure to set the span gas is identical to setting the zero gas. For example, set the span gas for a gas that is 50% O_2 and 50% N_2 for an equilibration time of 4 minutes:

AUTO CALIBRATION MENU Set Span Gas?	Press YES to enter the Set Span Gas option.
Span Gas %O_2 [XX.X]	(The X's represent the previously entered value.)
Span Gas %O_2 [50.00]	Use numeric keys to enter a 5 and 0 for 50% oxygen, then press YES twice to confirm the entry and proceed to the next prompt.
Span Gas ON for MM.SS [X.XX]	(The X's represent the previously entered equilibration time.)
Span Gas ON for MM.SS [4.00]	Enter the equilibration time (in this case a 4 for 4 minutes), then press YES to confirm the entry.
AUTO CALIBRATION MENU Set Span Gas?	Press YES to exit.
AUTO CALIBRATION MENU Set Settling Time?	Press NO to proceed to the next option.

Set Settling Time?

Enter the amount of time the process gas should remain on before the unit resumes taking measurements. Enter the time in minutes and seconds.

Note: *Alarms and recorders are not updated during the settling period.*

Settling Time: MM.SS [XX.XX]	Press YES to enter the Set Settling Time option. (The X's represent the previously entered value.)
Settling Time: MM.SS [14.30]	Use the numeric keys to enter the desired settling time, then press YES to confirm the entry.
AUTO CALIBRATION MENU Set Settling Time?	Press YES again to exit.
AUTO CALIBRATION MENU Set Error Handling?	Press YES again to exit.

Set Error Handling?

Use the Set Error Handling option to program the display screen, the alarms, and the recorders to respond to any invalid measurement that occurs during Auto Cal.

Follow the steps below to enable Error Handling, set the display screen, and select the alarm and recorder responses.

AUTO CALIBRATION MENU Set Error Handling?	At this prompt press YES to set the Error Handling option.
Enable Error Handling [YES] no	Use the NO or arrow keys to make the desired selection, then press YES to confirm the entry.
Auto Cal Error Effects: Set Display Response?	Press YES to set the display response.
Display AutoCal Error? [YES] no	Use the NO or arrow keys to make the desired selection, then press YES to confirm the entry.
Auto Cal Error Effects: Set Alarm Response?	Press YES to set the alarm response.
Select Alarm Effects No Effect?	Use the NO or arrow keys to make the desired selection, then press YES at the desired alarm response.
Select Alarm Effects Trip High?	
Select Alarm Effects Trip Low?	
Select Alarm Effects Trip Both?	

Set Error Handling? (cont.)

Auto Cal Error Effects: Set Recorder Response?	Press YES to set the recorder response.
Select Recorder Effect No Effect?	Use the NO or arrow keys to make the desired selection, then press YES at the desired recorder response.
Select Recorder Effect Force High?	
Select Recorder Effect Force Low?	
Select Recorder Effect Hold Last Value?	
Auto Cal Error Effects: Done?	Press NO until the “Done?” prompt appears.
AUTO CALIBRATION MENU Set Error Handling?	Press YES to return to the Set Error Handling option.
AUTO CALIBRATION MENU Perform AutoCal?	Press NO to proceed to the next option.

Perform AutoCal?

The Perform AutoCal option is used to activate the Auto Cal procedure without waiting for the specified Auto Cal interval.

When an Auto Cal is performed, either by pressing YES at “Perform AutoCal?” or when the specified time arrives, the following occurs:

- The top line of the display changes to “*Auto Cal in Progress*.” At this point, the Process/Cal relay will trip to the Cal position, and the Zero/Span relay will trip to the Span position.
- The second line of the display reads “Span Gas is ON,” along with the equilibration time. The equilibration time will begin counting down to zero.

The Auto Cal can be interrupted at this point by pressing NO. The Display will prompt “Abort AutoCal?” Two things can be done:

- Press NO to resume the countdown.
- Press YES to return the Display to the state it was in previous to the Auto Cal.

When the equilibration time reaches zero, the Display will read “Measuring...” and count down the measurement cycles. At the end of the measurement, the Zero/Span relay will reset to the Zero position, and the second line of the display will change to “Zero Gas is ON.” The equilibration countdown and the measurement countdown are performed as for the span gas.

At the end of the Auto Cal procedure, the Process/Cal relay will reset to the Process position and the settling time will count down to zero. The Display then reads “Working. . .” as it performs the curve fitting functions.

Note: *To set Auto Cal to begin automatically, refer to page 4-17.*

Perform AutoCal? (cont.)

To manually activate the Auto Cal procedure:

AUTO CALIBRATION MENU Perform AutoCal?	Press YES to activate Auto Cal.
Auto Cal in Progress Span Gas is ON XX.XX	(The X's represent the countdown for gas equilibration time.) When the span gas equilibration time reaches 0, the following prompt occurs:
Auto Cal in Progress Measuring. . . XX	When the span gas measuring countdown reaches 0, the following prompt occurs:
Auto Cal in Progress Zero Gas is ON XX.XX	When the zero gas equilibration time reaches 0, the following prompts occur:
Auto Cal in Progress Measuring. . . XX	
Auto Cal in Progress Settling. . . XX:XX	When the span gas measuring countdown reaches 0, the following prompt occurs:
Working . . .	When the process gas settling time reaches zero, the unit immediately applies the Auto Cal results to the calibration data before returning to the Auto Cal menu.
AUTO CALIBRATION MENU Perform AutoCal?	Press NO to proceed to the next option.
AUTO CALIBRATION MENU Zero AutoCal?	

Zero AutoCal?

Selecting this option causes the Display to reset the Auto Cal drift curve to the original calibration data.

AUTO CALIBRATION MENU Zero AutoCal?	Press YES to enter the Zero Auto Cal option.
Zero AutoCal? [YES] no	Use the NO or arrow keys to select the desired entry. Select YES to zero the Auto Cal drift curve.
Working . . .	Select NO to cancel the process and return to the Auto Cal Menu.
AUTO CALIBRATION MENU Zero AutoCal?	Press NO to proceed to the next option.

View Drift Curve?

Selecting this option allows the user to view the Auto Cal drift curve.

AUTO CALIBRATION MENU View Drift Curve?	Press YES to scroll through the drift curve.
Drift Values: X .XX %O2, X.XX mA	Press YES to exit and return to the Auto Cal Menu.

Note: *If the unit is uncalibrated and/or has not undergone the auto cal procedure (no calibration data has been previously entered) there will be no points in the drift curve.*

AUTO CALIBRATION MENU View Drift Curve?	Press NO to proceed to the next option.
AUTO CALIBRATION MENU Done?	Press YES to exit.
CALIBRATION MENU Auto Cal Parameters?	Press NO to proceed to the next submenu.
CALIBRATION MENU Edit Calibration Data?	

Edit Calibration Data?

The Edit Calibration submenu contains the following two options:

- Enable Compensation (for Pressure and Background)
- No Compensation (for Normal or Damped Response)

Note: *Normal response may NOT be used in conjunction with either pressure or background compensation.*

```
CALIBRATION MENU
Edit Calibration Data?
```

At the "Edit Calibration Data?" prompt, press YES to enter the Enable Compensation option.

Proceed to the appropriate section to either enable compensation or select no compensation.

To Enable Compensation:

```
Enable Compensation:
[YES]          no
```

Use the NO or arrow keys to select YES. Press YES to confirm the entry and enter the Select Compensation option.

The Select Compensation option allows the user to calibrate for either pressure or background compensation; proceed to the following sections for a description of each choice.

Edit Calibration Data? (cont.)

To Calibrate for Pressure Compensation, the user must enter both transducer data and pressure grid data:

Select Compensation: [PRES] bkgd	Use the NO or arrow keys to select PRES, then press YES to confirm the entry.
Calibrate - Pressure Transducer Data?	Press YES again to enter transducer data.
Pressure Curve Entry # of Points [2]:	Use the numeric keys to enter the number of points in the pressure transducer curve, then press YES to confirm the entry.
Point #1 mmHg [XXX.X]:	Press YES again to enter the pressure in mmHg for the given point in the transducer curve.
Point #1 mmHg [767.3]:	Use the numeric keys to enter the value, then press YES to confirm the entry.
Point #1 P mA [X.XX]:	Press YES again to enter the corresponding mA value for the given point in the transducer curve.
Point #1 P mA [9.17]:	Use the numeric keys to enter the value, then press YES to confirm the entry.

Repeat the procedure for each point in the transducer curve. The unit will then display the "Working" message before returning to the Calibrate - Pressure option.

Working . . .	.

Edit Calibration Data?
(cont.)

Calibrate - Pressure Transducer Data?	Press NO to proceed to the Enter Grid Data option.
Calibrate - Pressure Enter Grid Data?	Press YES to enter grid data.
Pressure Grid Entry # of Curves [2]:	Use the numeric keys to enter the number of curves in the pressure calibration grid, then press YES twice to confirm the entry and proceed to the next prompt.
Curve #1 mmHg [760.0]:	Use the numeric keys to enter the pressure in mmHg for each of the curves in the pressure grid, then press YES twice to confirm the entry and proceed to the next prompt.

Note: *Be sure to repeat the procedure for each curve number.*

Pressure Grid Entry # of Points [2]:	Use the numeric keys to enter the number of points in the pressure grid, then press YES twice to confirm the entry and proceed to the next prompt.
Point #1 O_2 [XX.X]:	Use the numeric keys to enter the percent gas concentrations for each of the points in each curve as prompted, then press YES to confirm the entry.

Note: *Percent gas concentrations MUST be in ascending order.*

Edit Calibration Data? (cont.)

XX.X %O_2, XXX.X mmHg Enter Point? yes [NO]

At this prompt, select YES to enter the calibration data for the given point, or select NO to have the unit determine the value for the given point.

Note: *Each curve must have AT LEAST TWO entered data points.*

XX.X %O_2, XXX.X mmHg Enter Point? [YES] no

To enter the calibration data, use the NO or arrow keys to select YES, then press YES to confirm the entry.

XX.X %O_2, XXX.X mmHg O2 mA [X.XX]:

Use the numeric keys to enter the corresponding milliamp value for the given point.

Repeat the procedure for every point in the pressure grid. The unit will then display the "Working. . ." message before returning to the Calibrate - Pressure option.

Working . . .

Calibrate - Pressure Enter Grid Data?

At this prompt, press NO to proceed to the next option.

Calibrate - Pressure Done?

Then press YES to return to the Calibration Menu.

CALIBRATION MENU Edit Calibration Data?

At the "Edit Calibration Data?" prompt, press YES to enter the Enable Compensation option.

Edit Calibration Data? (cont.)

To Calibrate for Background Compensation, the user must enter background grid data.

Enable Compensation: [YES] no	At this prompt, use the NO or arrow keys to select YES, then press YES again to confirm the entry.
Select Compensation: pres [BKGD]	Use the NO or arrow keys to select BKGD, then press YES to confirm the entry.
Calibrate - Background Enter Grid Data?	Press YES again to enter grid data.
O_2 Grid Entry # of Curves [2]:	Use the numeric keys to enter the number of curves in the background grid, then press YES twice to confirm the entry and proceed to the next prompt.
O_2 Grid Entry # of Points [2]:	Use the numeric keys to enter the number of points, then press YES twice to confirm the entry and proceed to the next prompt.
Point #1 O_2 [XX.X]:	Use the numeric keys to enter the percent gas concentrations for each of the points in each curve as prompted, then press YES to confirm the entry.

Note: *Percent gas concentrations MUST be in ascending order.*

X.XX %O_2, Curve #1 Enter Point? yes [NO]	At this prompt, select YES to enter the calibration data for the given point, or select NO to have the unit determine the value for the given point.

Note: *Each curve must have AT LEAST TWO entered data points.*

Edit Calibration Data? (cont.)

X.XX %O_2, Curve #1 Enter Point? [YES] no

To enter calibration data, use the NO or arrow keys to select YES, then press YES to confirm the entry.

XX.XX %O_2, Curve # 1 O_2 mA [X.XX]:

Use the numeric keys to enter the corresponding gas input milliamp value for the given point, then press YES to confirm the entry.

XX.XX %O_2, Curve # 1 Comp mA [X.XX]:

Use the numeric keys to enter the corresponding comp input milliamp value for the given point.

Repeat the procedure for every point in the background grid. The unit will then display the "Working. . ." message before returning to the Calibrate - Background option.

Working . . .

Calibrate - Background Enter Grid Data?

At this prompt, press NO to proceed to the next option.

Calibrate - Background Done?

Press YES to return to the Calibration Menu.

No Compensation:

The second option in the Edit Calibration Data submenu is No Compensation (for Normal or Damped Response). Refer to page 4-30.

Proceed to the following sections for NORMAL or DAMPED response.

CALIBRATION MENU Edit Calibration Data?	At this prompt, press YES to enter the Enable Compensation option.
Enable Compensation: yes [NO]	Use the NO or arrow keys to select NO.
Set System Response: normal [DAMPED]	Press YES to confirm the entry and enter the Set System Response option.

Note: *Normal response may NOT be used in conjunction with either pressure or background compensation.*

(Refer to page 4-39 for Damped Response).

Normal Response:

Set System Response: [NORMAL] damped	At this prompt use the NO or arrow keys to select "NORMAL," then press YES to confirm the entry.
Calibrate - Oxygen Enter Grid Data?	Press YES to enter grid data.
O_2 Grid Entry # of Points [2]:	Use the numeric keys to enter the number of points in the gas calibration curve, then press YES twice to confirm the entry and proceed to the next prompt.

No Compensation (cont.)

Normal Response (cont.)

Point #1 %O_2 [XX.XX]:	Use the numeric keys to enter the percent gas concentrations for each of the points in the curve as prompted, then press YES to confirm each entry.

Note: *Percent gas concentrations MUST be in ascending order.*

XX.XX %O_2 O_2 mA [XX.XX]:	Use the numeric keys to enter the corresponding mA values for the given percent gas concentration.

The unit will then display the "Working. . ." message before returning to the Calibrate - Oxygen option.

Working . . .	
Calibrate - Oxygen Enter Grid Data?	At this prompt, press NO to proceed to the next option.
Calibrate - Oxygen Done?	Then press YES to exit to the Calibration Menu.
CALIBRATION MENU Edit Calibration Data?	At the "Edit Calibration Data?" prompt, press NO to return to the main Calibration Menu.
CALIBRATION MENU Done?	Press YES to return to the Main Menu.

No Compensation (cont.)

Damped Response:

Set System Response: normal [DAMPED]	At this prompt, use the NO or arrow keys to select "DAMPED," then press YES to confirm the entry.
Calibrate - Oxygen Enter Grid Data?	Press YES to enter grid data.
O_2 Grid Entry # of Points [3]:	Use the numeric keys to enter the number of points in the gas calibration curve, then press YES twice to confirm the entry and proceed to the next prompt.
Point #1 $\%O_2$ [XX.XX]:	Use the numeric keys to enter the percent gas concentrations for each of the points in the curve as prompted, then press YES to confirm each entry.

Note: *Percent gas concentrations MUST be in ascending order.*

XX.XX $\%O_2$ O_2 mA [XX.XX]:	Use the numeric keys to enter the corresponding mA values for the given percent gas concentration.

The unit will then display the "Working. . ." message before returning to the Calibrate - Oxygen option.

Working . . .	
Calibrate - Oxygen Enter Grid Data?	At this prompt, press NO to proceed to the next option.
Calibrate - Oxygen Done?	Then press YES to exit to the Calibration Menu.

No Compensation (cont.)

CALIBRATION MENU Edit Calibration Data?	Press NO to return to the main Calibration Menu.
CALIBRATION MENU Done?	Press YES to return to the Main Menu.

Chapter 5

Specifications

TMO2 Oxygen Transmitter. 5-1

TMO2D Display Specifications 5-2

TMO2 Oxygen Transmitter

Measuring Ranges:
0-1% O_2, 0-2% O_2, 0-5% O_2,
0-10% O_2, 0-25% O_2, 0-100% O_2

Measurement Resolution: 0.01% O_2

Accuracy: 1% of span

Linearity: 0.1% of span

Repeatability: 0.2% of span

Drift: Zero and span, 0.8% of span/month
(0-2% O_2 range and higher)
1.5% of span/month (0-1% O_2 range)

Speed of Response: 4 seconds for
63% of a step change in O_2 (with Display)

Ambient Temperature Influence:
Negligible if transmitter is heated at least 5°C (9°F) above highest ambient temperature

Transmitter Temperature: Controlled to 45°C (113°F)

Atmospheric Pressure Influence: 0.2% of span per mm Hg (optional pressure compensation available)

Sample Flow Rate Influence:
Less then 1% of span with 50 to 1000 cc/mm, no flame arrestors (0.1 to 2 SCFH)

Line Voltage Influence: Negligible

Ambient Requirements:
Relative Humidity: 0-100% (non-condensing)
Temperature: -20 to 40°C (-4 to 104°F) higher temperatures available

Sample Requirements:
Flow: 50 to 1000 cc/min (0.1 to 2 SCFH)
Pressure: 20 psig maximum

Power Requirements: 24 VDC, 1A max
Powered by TMO2D electronics

Electrical Output: 0/4-20 mA to TMO2D electronics

Transmitter/Electronics Separation:
300 m (1000 ft) maximum shielded cable not required

Physical Characteristics:
Dimensions (H x W x D):
143 x 152 x 235 mm
(5.625 x 6 x 9.25 inches)
Weight: 4.3 Kg (9.5 lbs)

TMO2 Oxygen Transmitter (cont.)

Connections:
3/4-in. NPTF (electrical conduit)
1/4-in. NPTF (sample inlet & outlet)

Area Classification:
Explosion-proof/weatherproof
INIEX Cert. # 90C. 103.882 to
CENELEC EEx d IIC T6

TMO2D Display Specifications

Performance

Accuracy:
±0.1% of span (electronics only)

Ambient Temperature Effect:
±0.01% of full scale per °C

Functional

Analog Output:
Standard: Single, isolated 0/4-20 mA, 500 ohm maximum, field programmable
Optional: Dual, isolated 0/4-20 mA, 500 ohm maximum, field programmable

Alarms:
Standard: Two Form C, SPDT, 2 A max. @117 VAC, field programmable, 0.01% set-point resolution, 0.05 % of span dead band
Optional: Two hermetically-sealed relays for Class I, Div. 2 hazardous areas, 2 standard or hermetically-sealed relays for automatic calibration (Auto Cal)

Digital Output: RS-232C serial port

Display: 2-line x 24 character backlit LCD

Analog Input: 4 to 20 mA from TMO2-TC Transmitter

Power:
100/120/220/240 VAC +/- 10%, 50/60 Hz, 35 watts max., provides 24 VDC, 1 A max. to TMO2-TC Transmitter

Fuses:
110/120 VAC: 0.5 A, Slo-Blo.
220/240 VAC: 0.25 A, Slo-Blo.

Temperature:
Operating: 0 to +50°C (+32 to +122 °F)
Storage: -20 to +70°C (-4 to +158°F)

Physical

Dimensions:
Rack Mount: 5.25" (H) x 19" (W) x 9.25" (D)
(133 x 483 x 235 mm)
*Bench Mount:*5.25" (H) x 9" (W) x 9.25" (D)
(133 x 229 x 235 mm)
*Panel Mount:*5.25" (H) x 9" (W) x 9.25" (D)
(133 x 229 x 235 mm)
Weatherproof, fiberglass: 11.25" (H) x 9.38" (W) x 4.38" (D)
(286 x 238 x 111 mm)
Weatherproof, stainless steel: Consult factory
Explosion-proof: Consult factory

Weight:
Rack Mount: 5.4 lbs (2.4 kg)
Bench Mount: 7.4 lbs (3.4 kg)
Panel Mount: 4.7 lbs (2.1 kg)
Weatherproof, fiberglass: 6.5 lbs (3.0 kg)
Weatherproof, stainless steel: Consult factory
Explosion-proof: Consult factory

Environmental:
Rack, Bench, Panel Mount: General-purpose
Weatherproof, fiberglass: NEMA-4X; IP65
Weatherproof, stainless steel: Consult factory
Explosion-proof: Consult factory

European Compliance:
This unit complies with EMC Directive 89/336/EEC and 73/23/EEC Low Voltage Directive. (Installation Category II, Pollution Degree II.)

Appendix A

Thermoparamagnetic (Magnetic Wind) Theory

Basic Principle A-1

The TMO2 Transmitter Oxygen Measurement Bridge. A-1

The TMO2 Transmitter Compensation Bridge A-2

TMO2D Electronics Microprocessor-based Compensation for Variations in Background Gas Composition A-2

Basic Principle

Since its magnetic susceptibility is approximately 100 times greater than most common gases, oxygen can be easily distinguished from other gases based on its attraction into a magnetic field. The magnetic susceptibility of oxygen varies with temperature — more strongly attracted at low temperatures, and less at high temperatures. Therefore, by carefully combining a magnetic field gradient and a temperature gradient with the TMO2 transmitter measuring cell, an oxygen-containing gas can be made to flow, creating "magnetic wind." The intensity of this induced flow depends on the concentrations of oxygen in the sample.

The TMO2 Transmitter Oxygen Measurement Bridge

In the TMO2 transmitter measuring cell, permanent magnets are used to create a magnetic field. The temperature within the measuring cell is controlled to a constant 113° (45°C) to maintain thermal equilibrium. The cell also contains two pairs of thermistors, with one thermistor of each pair located within the magnetic field. Since the thermistors are electrically heated, a temperature gradient is created within the magnetic field.

When a small sample of oxygen-containing gas diffuses into the measuring cell, it is attracted to the field, causing the sample pressure to become locally higher. The sample pressure is slightly lower in the vicinity of the thermistors because the gas is less strongly attracted at higher termperatures. This difference in sample pressure causes the gas to flow out from the center of the magnetic field and over the thermistors. The inner, wind generating thermistors decrease in temperature as they lose heat to the magnetic wind, while the outer, wind receiving thermistors increase in temperature as they pick up heat from the magnetic wind.

The thermistor pairs are additively connected in an electronic measuring bridge circuit. The circuit is unbalanced as the electrical resistance of the thermistors change with temperature. The circuit imbalance causes a voltage to appear across the bridge which is proportional to the oxygen concentration in the gas being measured. (See Figure A-1 on the following page.)

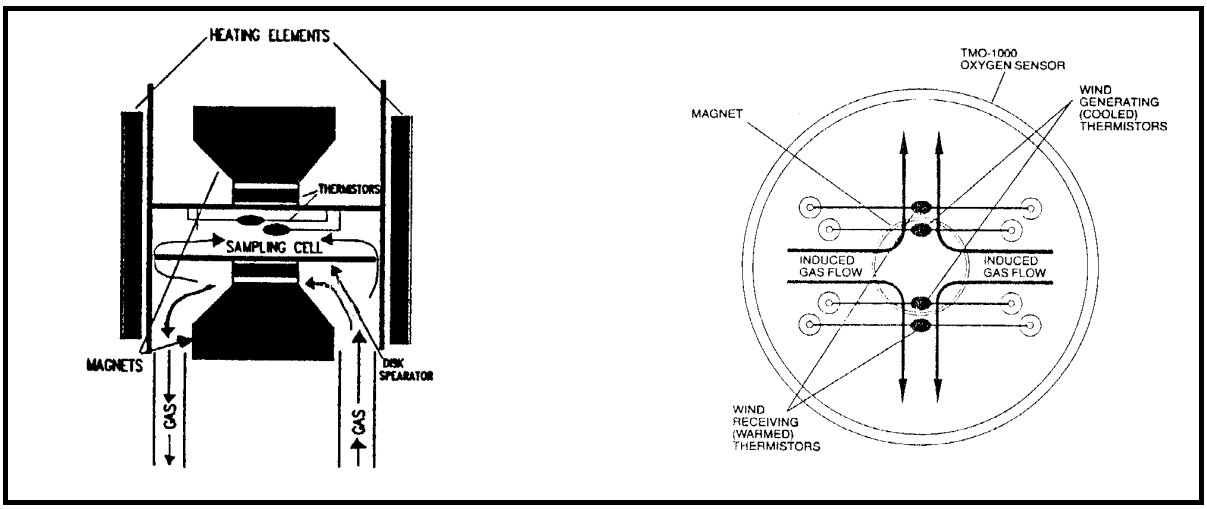


Figure A-1: The TMO2 Oxygen Transmitter

The TMO2 Transmitter Compensation Bridge

As the background gases which make up the balance of an oxygen-containing mixture change, the thermal and magnetic properties change and affect heat transfer to and from the thermistors. This is ultimately reflected in thermistor temperature, and will affect oxygen measurement if left uncompensated.

For this reason, the TMO2 transmitter features a unique "bridge-within-a-bridge-circuit." The oxygen measuring bridge described above is one arm of yet another compensation bridge which maintains the oxygen bridge at a constant temperature regardless of variations in background gas compensation.

TMO2D Electronics Microprocessor-based Compensation for Variations in Background Gas Composition

By sensing the compensation bridge current necessary to restore oxygen bridge temperature, a signal is obtained which is transmitted to the TMO2D electronics where microprocessor-based background gas compensation is performed.

Appendix B

Outline and Installation Drawings

TMO2 Outline and Installation (Dwg. #712-211). B-1

TMO2D Rack Model Outline and Installation (Dwg. #421-255). . B-2

TMO2 Oxygen Analyzer Assembly (Dwg. #705-468). B-3

PCB Analyzer Assembly (Dwg. #703-1036) B-4

TMO2D Top Assembly (Dwg. #705-517, sh. 2). B-5

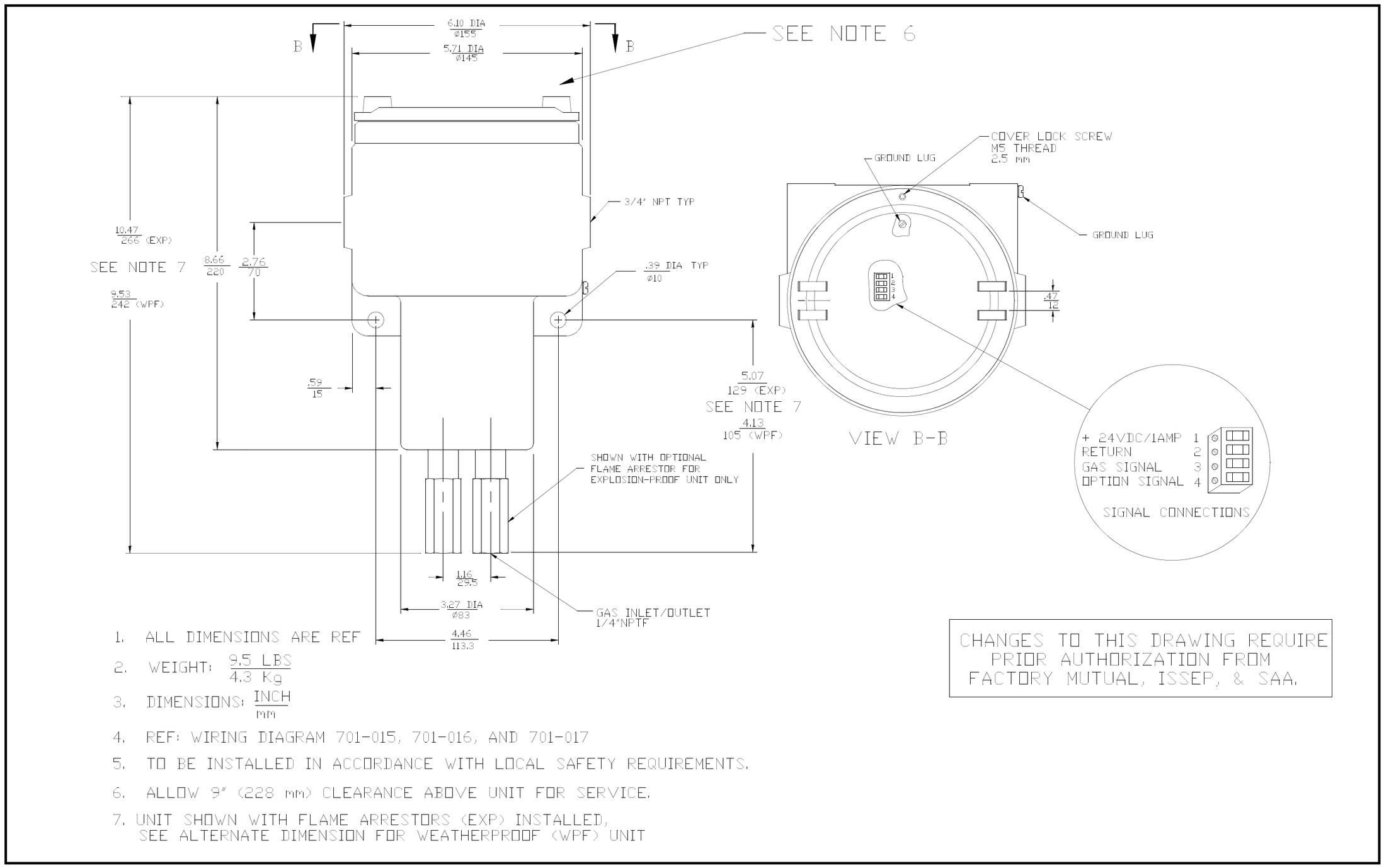
Analyzer PCB Schematic (Dwg. #700-1036). B-6

Oxygen Analyzer Display PCB Assembly (Dwg. #703-1226) . . . B-7

Oxygen Analyzer Display PCB Schematic (Dwg. #700-1226, sh. 1) B-8

Oxygen Analyzer Display PCB Schematic (Dwg. #700-1226, sh. 2) B-9

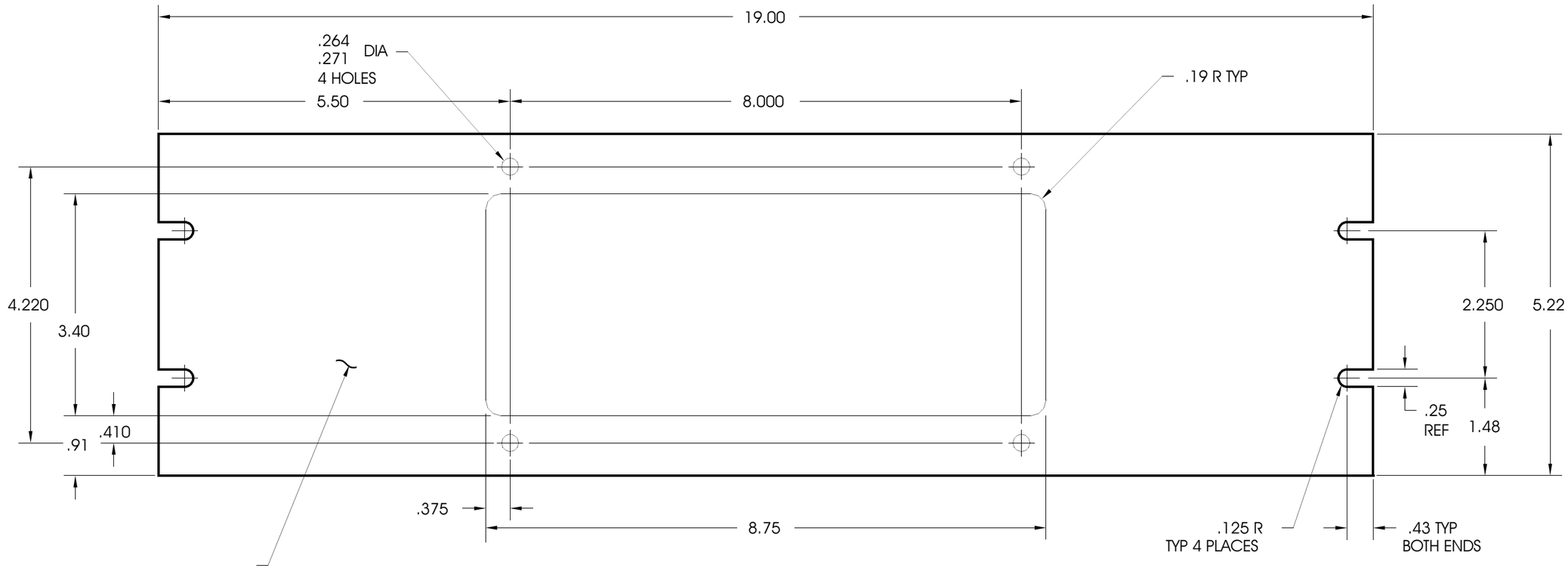
Oxygen Analyzer Display PCB Schematic (Dwg. #700-1226, sh. 3) B-10



1. ALL DIMENSIONS ARE REF
2. WEIGHT: 9.5 LBS / 4.3 Kg
3. DIMENSIONS: INCH / mm
4. REF: WIRING DIAGRAM 701-015, 701-016, AND 701-017
5. TO BE INSTALLED IN ACCORDANCE WITH LOCAL SAFETY REQUIREMENTS.
6. ALLOW 9" (228 mm) CLEARANCE ABOVE UNIT FOR SERVICE.
7. UNIT SHOWN WITH FLAME ARRESTORS (EXP) INSTALLED, SEE ALTERNATE DIMENSION FOR WEATHERPROOF (WPF) UNIT

CHANGES TO THIS DRAWING REQUIRE PRIOR AUTHORIZATION FROM FACTORY MUTUAL, ISSEP, & SAA.

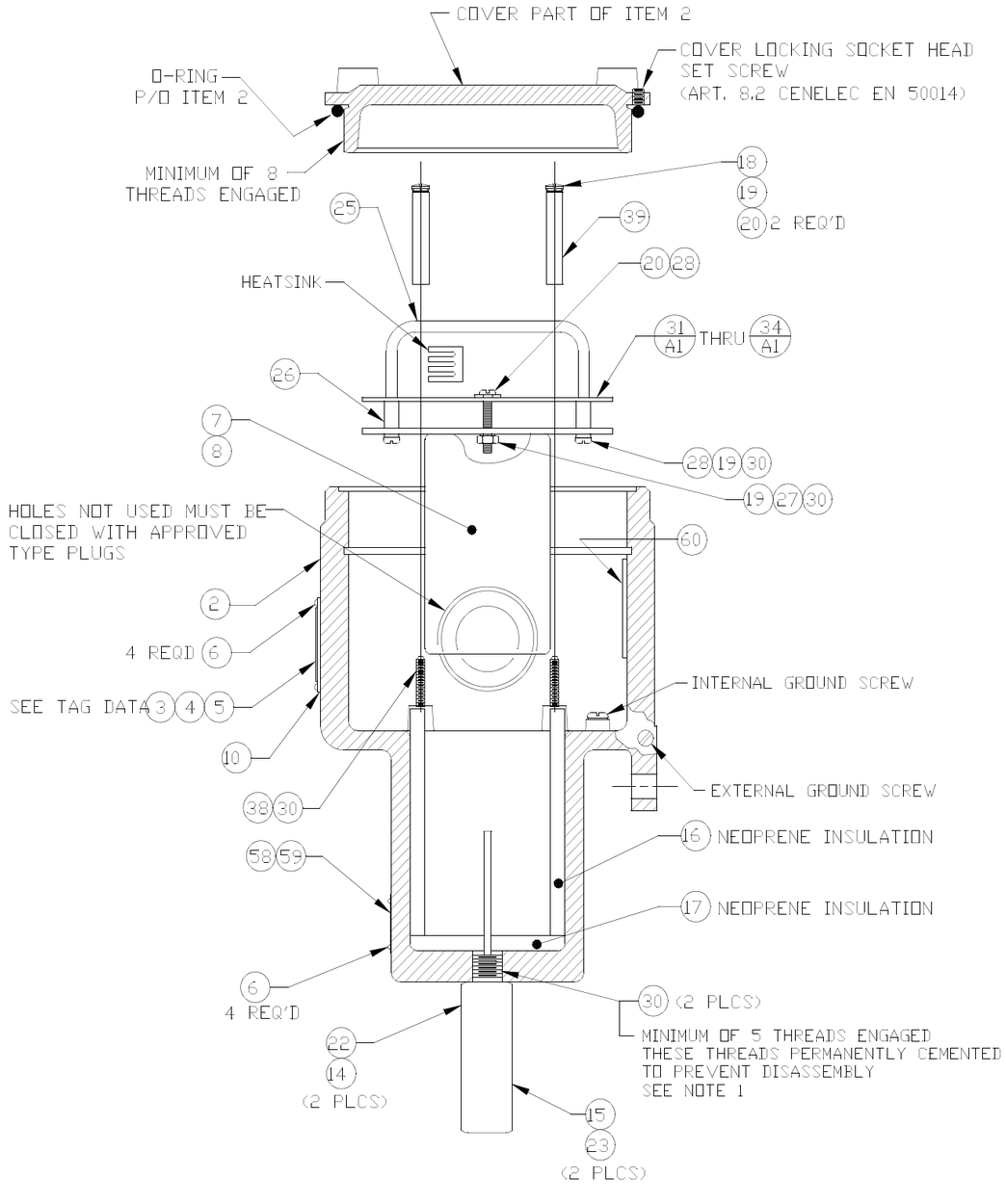
Figure B-1: TMO2 Outline and Installation (Dwg. #712-211)

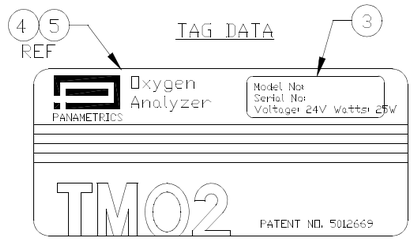


NOTES:

1. MATERIAL: .12 THK 6061-T6 ALUMINUM ALLOY
2. FINISH: CLEAR IRIDITE
3. REMOVE ALL BURRS & SHARP EDGES
4. FRONT SURFACE TO BE FREE OF ALL SCRATCHES, BLEMISHES AND TOOL MARKS.
5. PAINT FRONT SURFACE & ALL EDGES DARK GRAY COLOR #26152 PER FED-STD-595
6. 10% SEMIGLOSS CLEAR EPOXY TOP COAT

Figure B-2: TMO2D Rack Model Outline and Installation (Dwg. #421-255)





NOTES:

1. USE EPOXY ADHESIVE OR SIMILAR PERMANENT CEMENTING COMPOUND
3. NOTE ORIENTATION OF HEATSINK WHEN INSTALLING INTERNAL ASSEMBLY.
4. PERFORM PRESSURE TEST 714-426 AFTER UNIT IS ASSEMBLED.

CHANGES TO THIS DRAWING REQUIRE PRIOR AUTHORIZATION FROM FACTORY MUTUAL AND ISSEP

Figure B-3: TMO2 Oxygen Analyzer Assembly (Dwg. #705-468)

THIS DRAWING IS A FACTORY MUTUAL RESEARCH
APPROVED DESIGN & NO CHANGE IS PERMITTED
UNLESS AUTHORIZED BY FACTORY MUTUAL

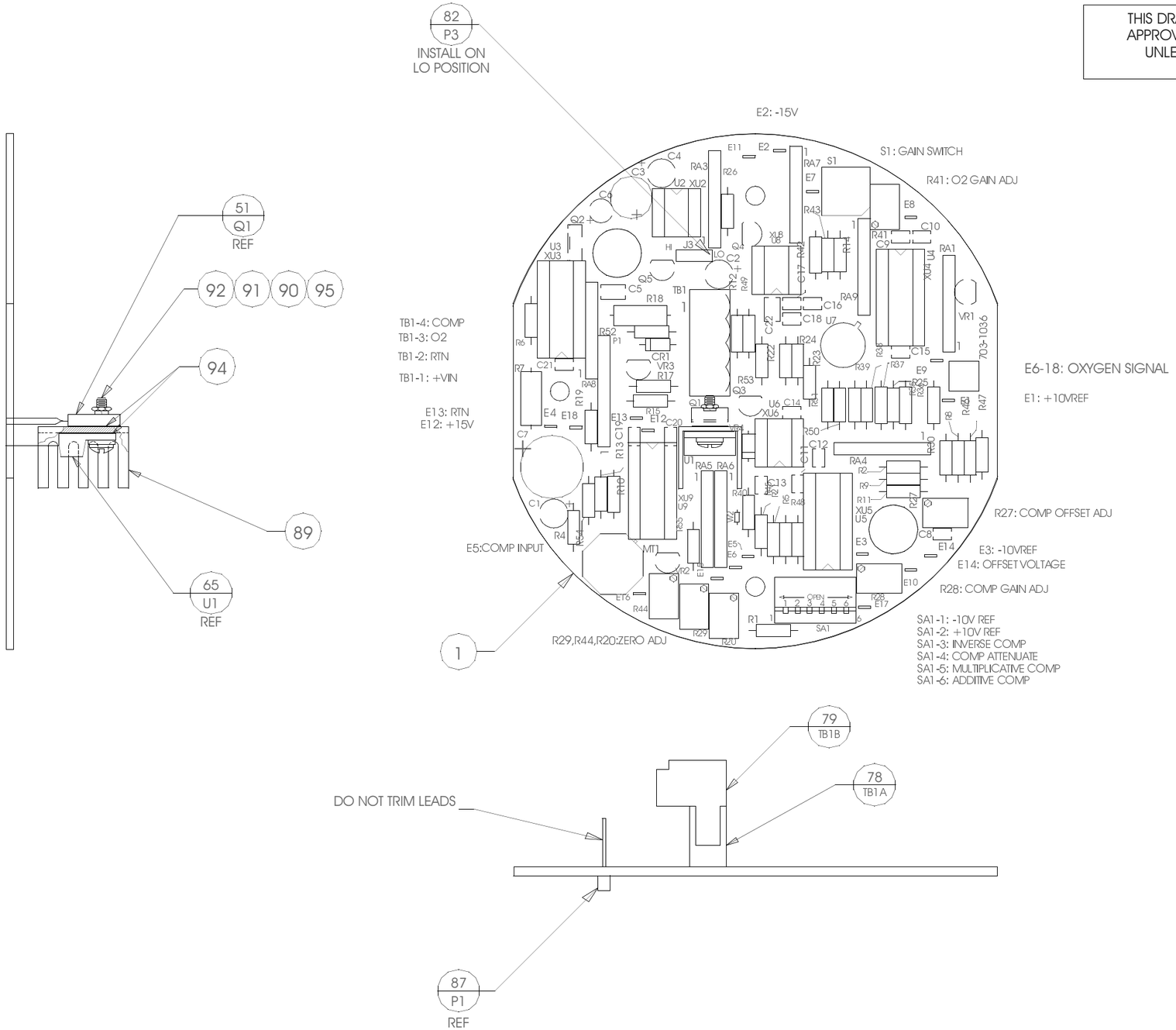
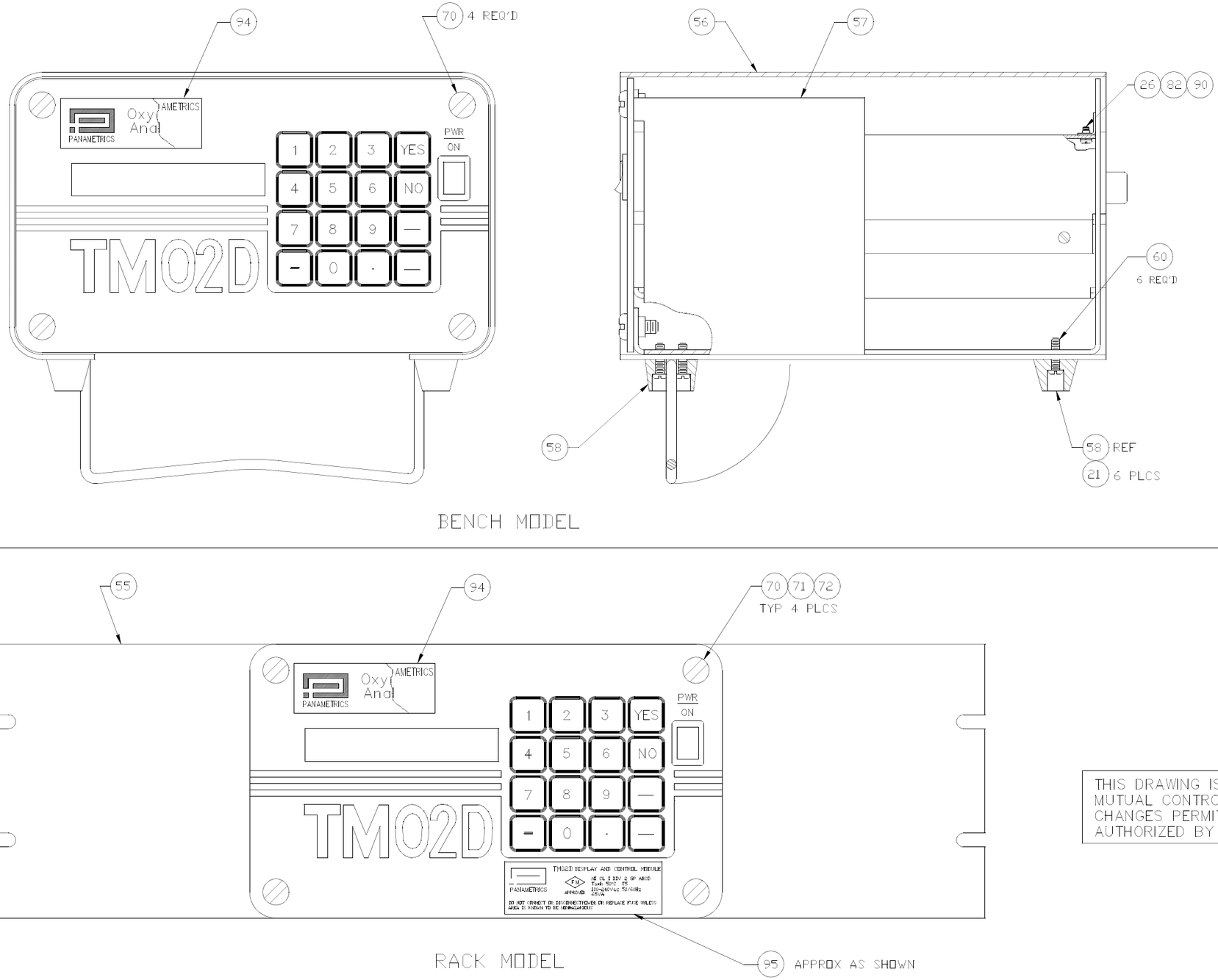


Figure B-4: PCB Analyzer Assembly (Dwg. #703-1036)



THIS DRAWING IS FACTORY MUTUAL CONTROLLED NO CHANGES PERMITTED UNLESS AUTHORIZED BY FACTORY MUTUAL

Figure B-5: TMO2D Top Assembly (Dwg. #705-517, sh. 2)

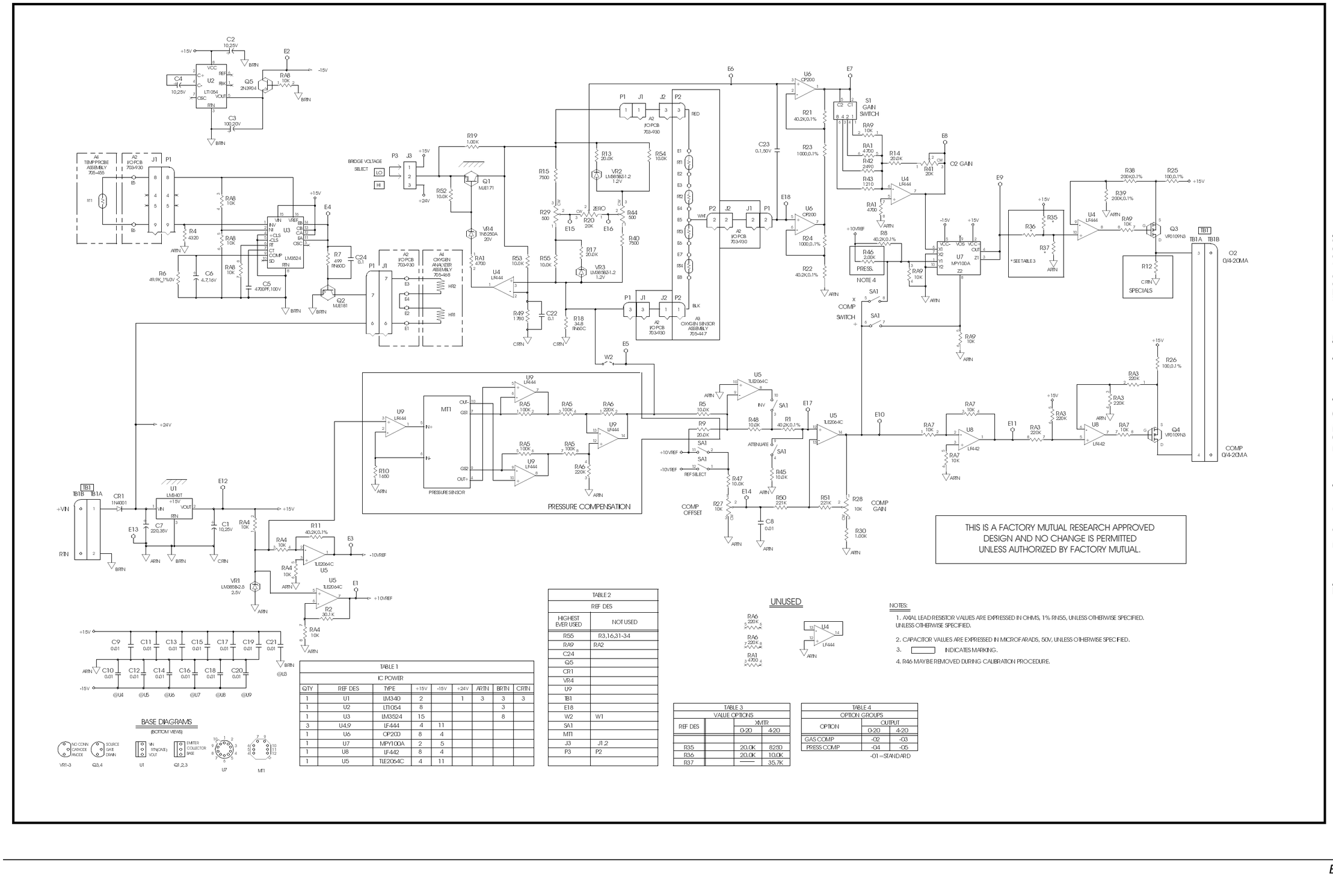

PRESSURE COMPENSATION
THIS IS A FACTORY MUTUAL RESEARCH APPROVED DESIGN AND NO CHANGE IS PERMITTED UNLESS AUTHORIZED BY FACTORY MUTUAL.
BASE DIAGRAMS
(BOTTOM VIEWS)
UNUSED
NOTES:
1. AXIAL LEAD RESISTOR VALUES ARE EXPRESSED IN OHMS, 1% RN55, UNLESS OTHERWISE SPECIFIED. UNLESS OTHERWISE SPECIFIED.
2. CAPACITOR VALUES ARE EXPRESSED IN MICROFARADS, 50V, UNLESS OTHERWISE SPECIFIED.
3. INDICATES MARKING.
4. R46 MAY BE REMOVED DURING CALIBRATION PROCEDURE.

TABLE 1
IC POWER

QTY	REF DES	TYPE	+15V	-15V	+24V	ARTN	BRTN	CRTN
1	U1	LM340	2		1	3	3	3
1	U2	LT1054	8				3	
1	U3	LM3524	15				8	
3	U4,9	LF444	4	11				
1	U6	OP200	8	4				
1	U7	MPY100A	2	5				
1	U8	LF442	8	4				
1	U5	TLE2064C	4	11				

TABLE 2
REF DES

HIGHEST EVER USED	NOT USED
R55	R3,16,31-34
RA9	RA2
C24	
Q5	
CR1	
VR4	
U9	
TB1	
E18	
W2	W1
SA1	
MT1	
J3	J1,2
P3	P2

TABLE 3
VALUE OPTIONS

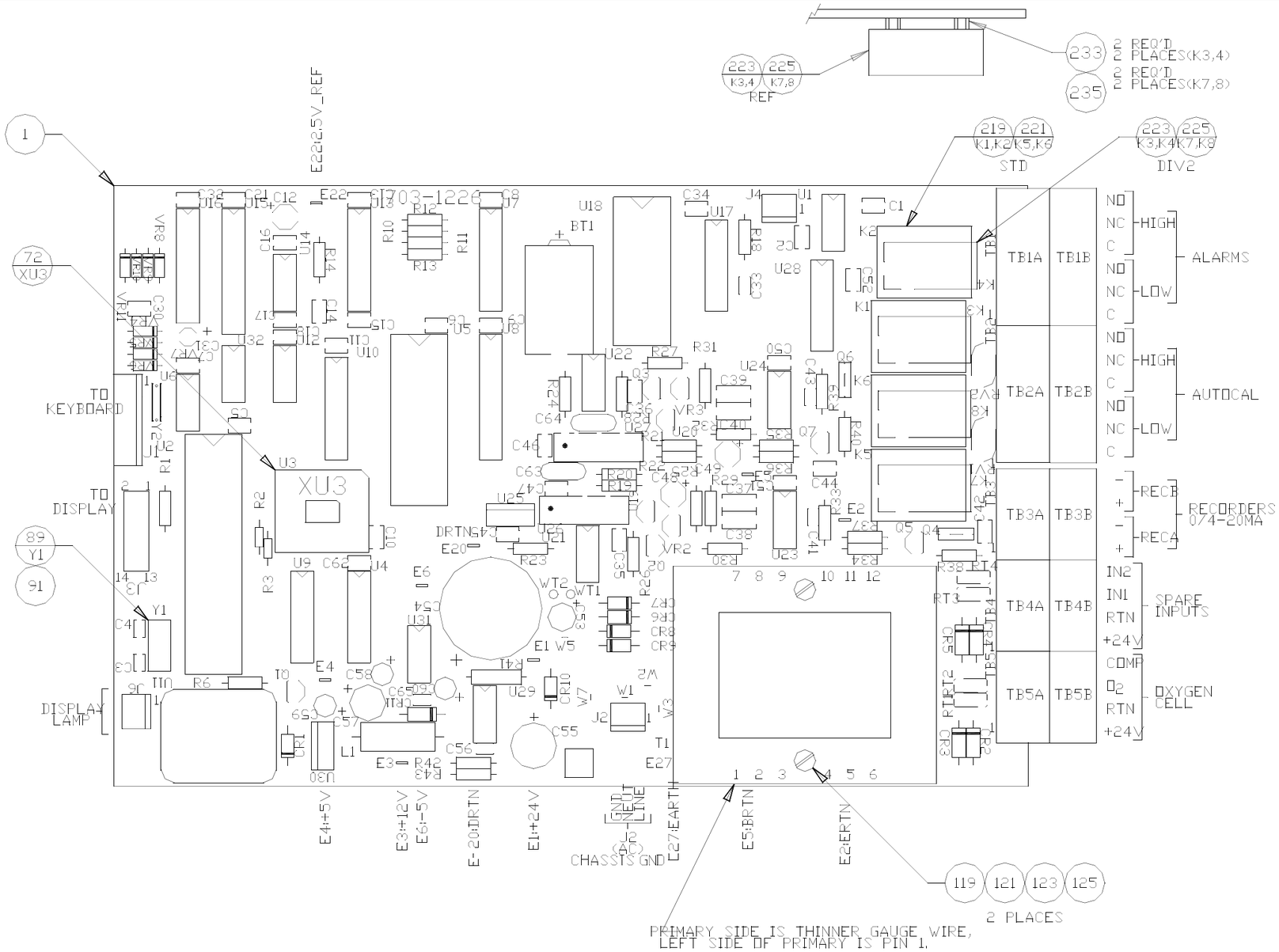
REF DES		XMTR	
		0-20	4-20
R35		20.0K	825Ω
R36		20.0K	10.0K
R37		—	35.7K

TABLE 4
OPTION GROUPS

OPTION	OUTPUT	
	0-20	4-20
GAS COMP	-02	-03
PRESS COMP	-04	-05

-01 = STANDARD

Figure B-6: Analyzer PCB Schematic (Dwg. #700-1036)



GROUP NUMBER TABLE			
VOLTAGE	OUTPUTS	RECORDERS STD	RECORDERS DUAL ISOL
100VAC	STD ALARM	-02	-14
	DIV2 ALARM	-03	-15
	STD ALARM/CAL	-04	-16
	DIV2 ALARM/CAL	-05	-17
120VAC	STD ALARM	-06	-18
	DIV2 ALARM	-07	-19
	STD ALARM/CAL	-08	-20
	DIV2 ALARM/CAL	-09	-21
220/240VAC	STD ALARM	-10	-22
	DIV2 ALARM	-11	-23
	STD ALARM/CAL	-12	-24
	DIV2 ALARM/CAL	-13	-25

GP-01=STANDARD

VOLTAGE/FUSE TABLE		
VOLTAGE	FUSE	JUMPER
100/120	1/2A	W1, W3
220/240	1/4A	W2

NOTE:
1. ASSEMBLE PER IPC-A-160 AND/OR PANAMETRICS STANDARD 957-002.
2. DO NOT INSTALL CR4, CR5, RT3, RT4, R12, R13, AND TB4B.
3. FOR WEATHERPROOF UNITS INSTALL JUMPER W5.

Figure B-7: Oxygen Analyzer Display PCB Assembly (Dwg. #703-1226)

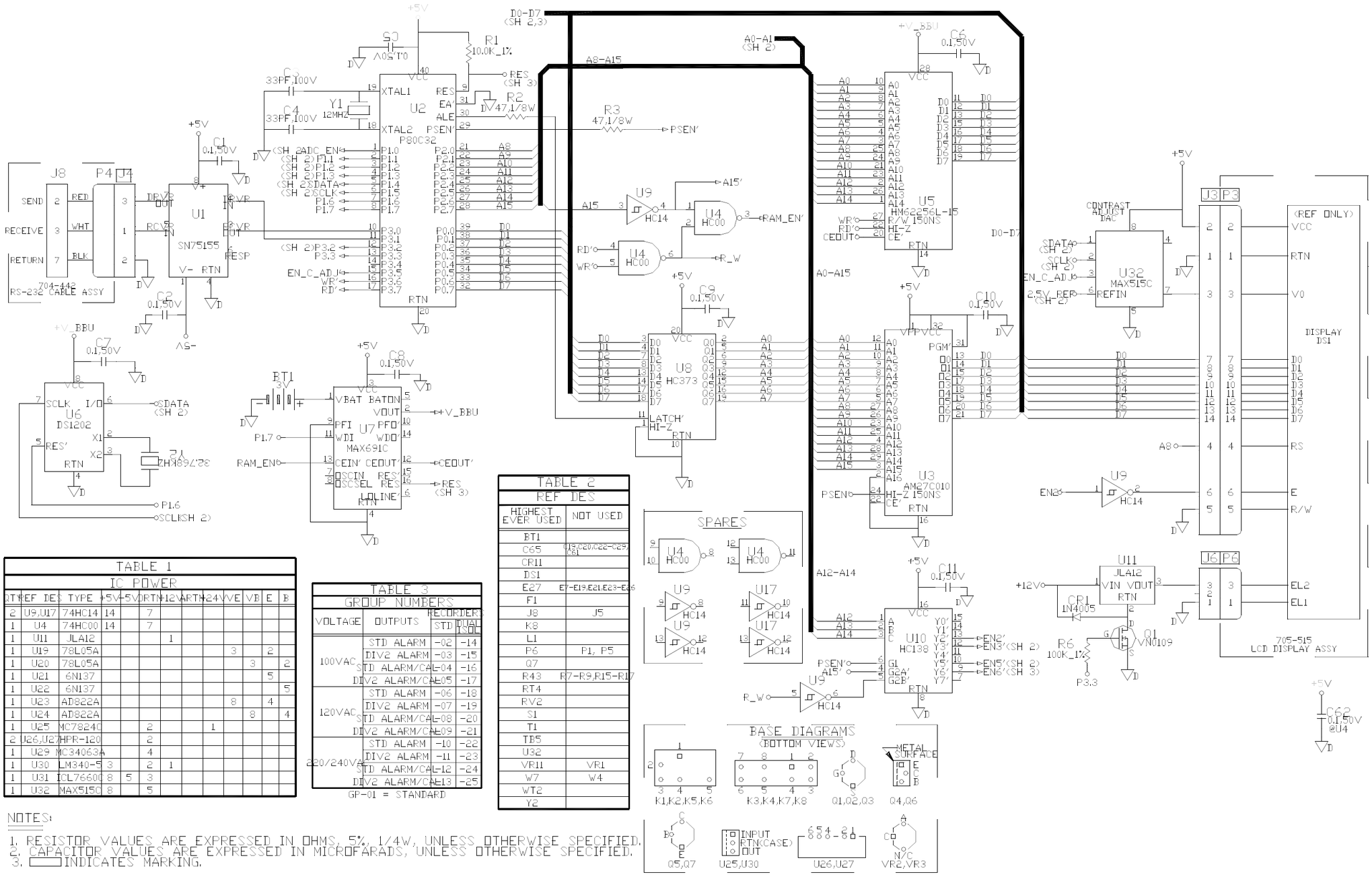


TABLE 1
IC POWER

QTY	REF DES	TYPE	+5V	-5V	ORTN	+12V	ARTN	+24V	VVE	VB	E	B
2	U9,U17	74HC14	14		7							
1	U4	74HC00	14		7							
1	U11	JLA12				1						
1	U19	78L05A							3		2	
1	U20	78L05A								3		2
1	U21	6N137									5	
1	U22	6N137										5
1	U23	AD822A							8		4	
1	U24	AD822A								8		4
1	U25	MC7824C			2			1				
2	U26,U27	HPR-120			2							
1	U29	MC34063A			4							
1	U30	LM340-5	3		2	1						
1	U31	ICL7660C	8	5	3							
1	U32	MAX515C	8		5							

TABLE 3
GROUP NUMBERS

VOLTAGE	OUTPUTS	RECORDER STD	RECORDER DUAL TSOC
100VAC	STD ALARM	-02	-14
	DIV2 ALARM	-03	-15
	STD ALARM/CAL	-04	-16
	DIV2 ALARM/CAL	-05	-17
120VAC	STD ALARM	-06	-18
	DIV2 ALARM	-07	-19
	STD ALARM/CAL	-08	-20
	DIV2 ALARM/CAL	-09	-21
220/240VAC	STD ALARM	-10	-22
	DIV2 ALARM	-11	-23
	STD ALARM/CAL	-12	-24
	DIV2 ALARM/CAL	-13	-25

GP-01 = STANDARD

TABLE 2
REF DES

HIGHEST EVER USED	NOT USED
BT1	
C65	C13,C20,C22-C29, C61
CR11	
DS1	
E27	E7-E19,E21,E23-E26
F1	
J8	J5
K8	
L1	
P6	P1, P5
Q7	
R43	R7-R9,R15-R17
RT4	
RV2	
S1	
T1	
TB5	
U32	
VR11	VR1
W7	W4
WT2	
Y2	

SPARES

BASE DIAGRAMS (BOTTOM VIEWS)

K1,K2,K5,K6 | K3,K4,K7,K8 | Q1,Q2,Q3 | Q4,Q6 | Q5,Q7 | U25,U30 | U26,U27 | VR2,VR3

NOTES:
1. RESISTOR VALUES ARE EXPRESSED IN OHMS, 5%, 1/4W, UNLESS OTHERWISE SPECIFIED.
2. CAPACITOR VALUES ARE EXPRESSED IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
3. ▭ INDICATES MARKING.

Figure B-8: Oxygen Analyzer Display PCB Schematic (Dwg. #700-1226, sh. 1)

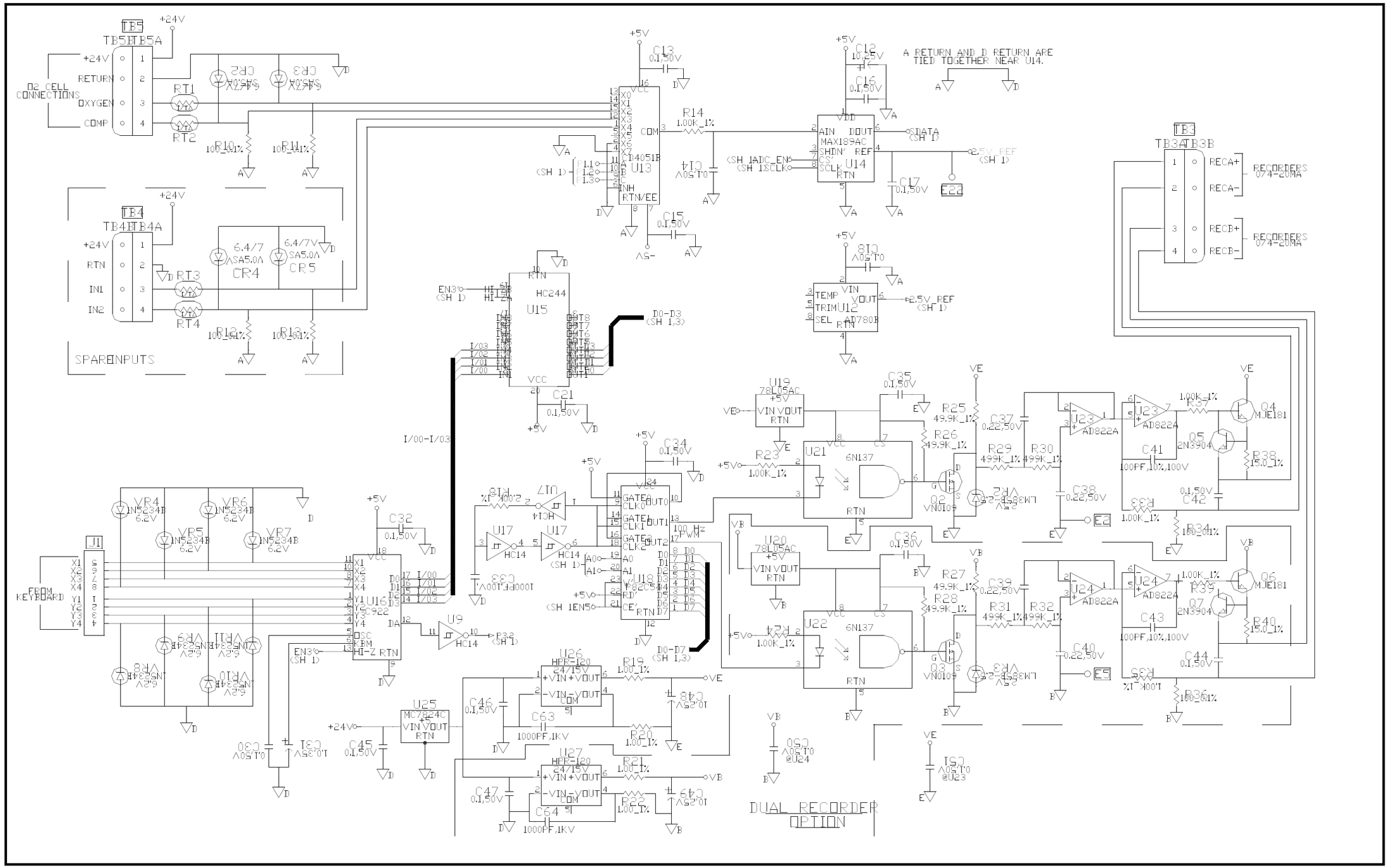


Figure B-9: Oxygen Analyzer Display PCB Schematic (Dwg. #700-1226, sh. 2)

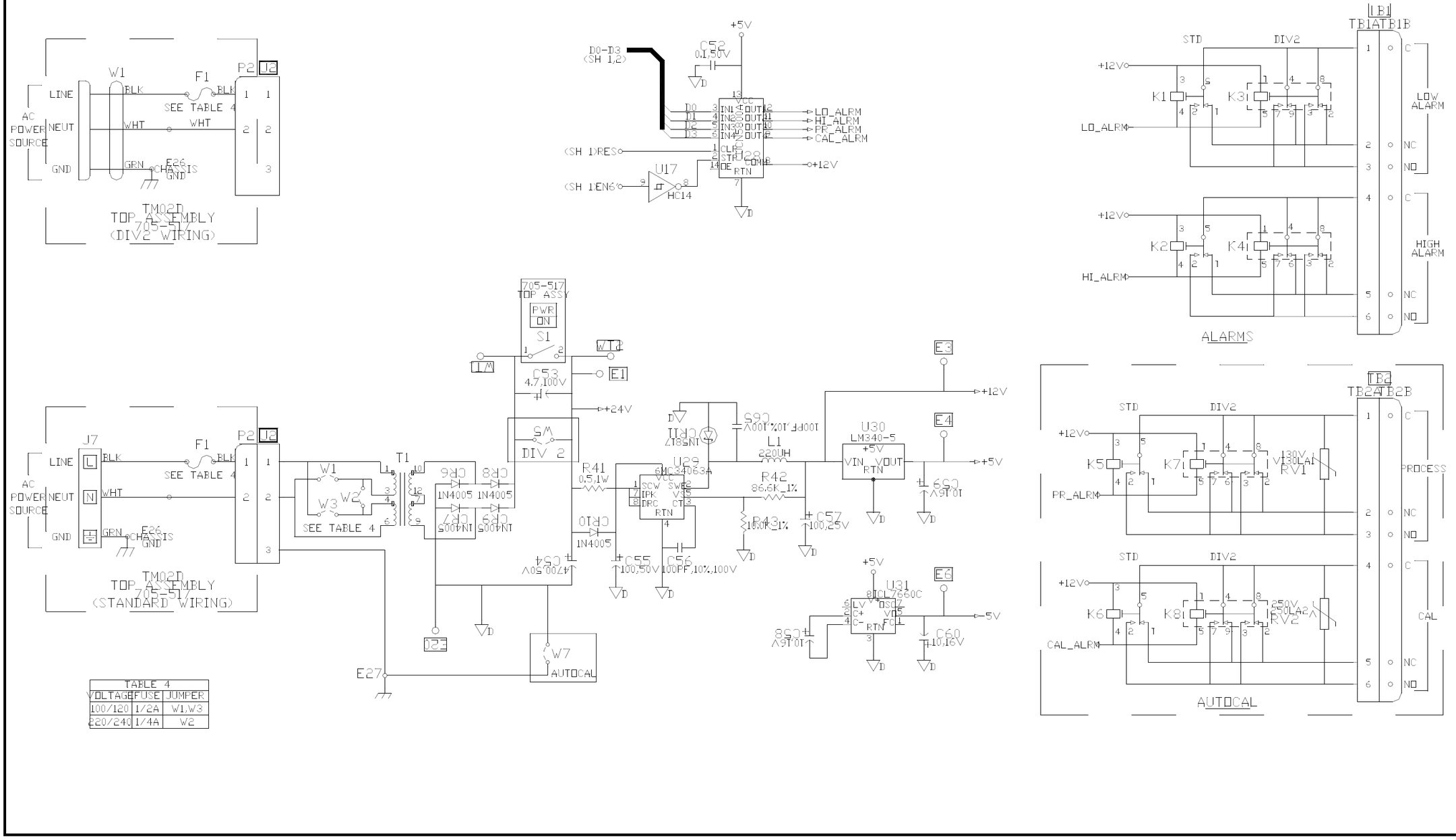


Figure B-10: Oxygen Analyzer Display PCB Schematic (Dwg. #700-1226, sh. 3)

Appendix C

RS-232C Serial Port

RS-232C Serial Port

The TMO2D contains a bidirectional, industry standard RS-232C serial port which can be connected to a terminal or computer that supports the RS-232C protocol (see Chapter 4, page 4-6).

All keypad and most display operations can be performed remotely through this serial port.

Table C-1 below provides an illustration of the terminal/computer keys and how they correspond to the keys on the display keypad.

Table C-1: TMO2D RS-232C Serial Port and Corresponding Keys

[1] 031 "1"	[4] 034 "4"	[7] 037 "7"	[-] 02D "-"
[2] 032 "2"	[5] 035 "5"	[8] 038 "8"	[0] 030 "0"
[3] 033 "3"	[6] 036 "6"	[9] 039 "9"	[.] 02E "."
[Y] 00D ENTER	[N] 01B ESCAPE	[←] 008 BACKSPACE	[→] 020 SPACE

Appendix D

The TMO2 Transmitter Calibration Procedure

Introduction D-1

Equipment and Drawings D-2

Setup D-3

Preliminary Explanation D-3

Internal Background Gas Compensation. D-5

External Compensation D-6

Internal Pressure Compensation D-7

External Pressure Signal Calibration D-8

Internal Hydrogen Gas Compensation. D-9

External Hydrogen Gas Compensation D-9

Internal Methane Gas Compensation (Reverse Compensation) D-9

Introduction

Factory calibration procedures are included here for reference only. Do not attempt factory calibration in the field. For field calibration, refer to the TMO2D calibration sheet that was shipped with your unit.

!WARNING!
TO ENSURE THE SAFE OPERATION OF THE TMO2D, YOU MUST INSTALL AND OPERATE IT AS DESCRIBED IN THIS MANUAL. IN ADDITION, BE SURE TO FOLLOW ALL APPLICABLE SAFETY CODES AND REGULATIONS FOR INSTALLING ELECTRICAL EQUIPMENT IN YOUR AREA.

Equipment and Drawings

Test Equipment:

- Two 3-1/2 digit DVMs, HP 3438A or equivalent
- Pressure generator 0-1 PSI

TMO2 Equipment:

- Completely assembled TMO2 oxygen analyzer

Sample Gas Equipment:

- Cylinder of 100% oxygen with regulator
- Cylinder of primary background gas (Gas A)
- Cylinder of secondary background gas (Gas B)
- Sample system to control/combine the above gasses

Drawings:

- 705-468, TMO2 Top Assembly
- 703-1036, Assembly, Analyzer PCB
- 700-1036, Schematic, Analyzer PCB
- 712-211, Outline and Installation

Setup

1. Connect gas inlet of the TMO2 transmitter to the sample system.

2. Connect 0-20 milliamp meter to TB1 of transmitter: pin 3 (+) and pin 2 (return).

3. Connect +24 VDC power supply to TB1 of the transmitter PCB. Connect the positive terminal to pin 1 and the negative terminal to pin 2 of the TB1. Turn on power and let transmitter warm up for at least 30 minutes.

Preliminary Explanation

The following procedures describe how to calibrate various TMO2 oxygen analyzers. Most analyzers have internal background gas compensation to correct the output for changes in the gas composition. To begin, the compensation will be fixed (to 2.00v), while the oxygen circuit is calibrated using zero and span (ex. 0% and 10%) oxygen. The primary background gas, referred to as Gas A, will compose the remainder of the mixture.

Next, the compensation circuit is calibrated. In this procedure, the TMO2 transmitter is exposed to full scale oxygen (ex. 10%) in a background of Gas A followed by full scale oxygen in Gas B, the secondary background gas.

The type of gases used for Gas A and Gas B will vary depending on the application. As an example, the calibration for a customer who uses the TMO2 to measure oxygen in a hydrogen tank would use hydrogen as Gas A. Nitrogen might be used for Gas B, since a system leak would inject air/nitrogen into the mixture.

In addition, circuits can be added to the analyzer board to provide pressure compensation, reverse compensation, and compensation attenuation. These options are switch selectable at calibration to provide proper compensation for hydrogen/helium, methane and pressure sensitive applications.

Swich SA1 on the circuit board is used to select the following six operating functions:

- SA1 - 1: Selects negative offset voltage
- SA1 - 2: Selects positive offset voltage
- SA1 - 3: Selects inverse compensation
- SA1 - 4: Selects compensation attenuation
- SA1 - 5: Selects multiplying compensation
- SA1 - 6: Selects additive compensation

Preliminary Explanation (cont.)

Zero adjustments are made via R20, R29, and R44. When properly adjusted, zero shift errors due to background gas changes can be reduced.

Oxygen signal gain is controlled by rotary switch (S1) and R41. S1 serves as a course gain conrol while R41 provides fine gain adjustment. Rotating either control in the clockwise direction provides increased gain.

Note: *Do not use the "0" position on S1.*

R27 and R28 provide the offset and gain adjustments for the compensation circuits.

High or low bridge voltage is selected via jumper plug J3. Low voltage should be used for most applications. High voltage is used with hydrogen and helium background gasses.

Most analyzers will be magnetized and marked as high (H), medium (M), or low (L) assemblies. The oxygen ranges that can be calibrated for each type of magnetization are:

Magnetization	O_2 Range
High (H)	0- 1, 2, 5, 10, 21%
Medium (M)	0- 25%, 95-100%
Low (L)	0- 100%

Internal Background Gas Compensation

Internal Background gas compensation is used to provide a single 0/4-20 milliamp oxygen signal that is constant despite changes in the gas composition.

Note: *In the following procedure, the gas mixture having the largest oxygen sensitivity should be used as Gas A.*

Set SA1 switches as follows: 1, 3, 4 & 6 = OFF (up position)
2 & 5 = ON
Set J3 to the LO position (HI if using hydrogen/helium).

Zero:

1. Set S1 to position 9 and adjust R41 fully clockwise.

2. Apply background Gas A (ex. 100% CO_2) into the oxygen transmitter.

3. Adjust R27 until the voltage at E14 equals +2.0 volts.

4. Adjust R28 until the voltage at E10 equals +2.0 volts.

5. Turn R20 fully clockwise.

6. Adjust R29 until TB1-3 is 0/4 milliamps.

7. Turn R20 fully counter-clockwise.

8. Adjust R44 until TB1-3 is 0/4 milliamps.

9. Repeat steps 5 through 8 as required.

10. Apply background Gas B (ex. 100% N_2) into the oxygen transmitter.

11. Adjust R20 until the output is 0/4 milliamps.

12. Reapply Gas A and fine tune R29 for 0/4 milliamps output.

Span Compensation:

1. Apply span/background Gas A (ex. 10% oxygen, remainder CO_2) into the oxygen transmitter.
2. Adjust S1 and R41 until the output is 20 milliamps.
3. Apply span/background Gas B (ex. 10% oxygen, remainder N_2) into the oxygen transmitter.
4. Adjust R28 until the output is 20 milliamps.
5. Reapply span/background Gas A (ex. 10% oxygen, remainder CO_2) into the oxygen transmitter.
6. Adjust R27 until the output is 20 milliamps.
7. Repeat steps 3 through 6 until a consistent output is obtained.

Note: *R27 and R28 are interdependent; adjustment of one pot will affect the setpoint of the other pot.*

External Compensation

A TMO2 transmitter with external compensation provides a separate 0-20 mA output to indicate the relative thermoconductivity of the gas mixture. In normally compensated transmitters this signal is internally multiplied by the internal oxygen signal to give a single compensated oxygen 0/4-20 mA output. In externally compensated transmitters, however, one output is an uncompensated oxygen signal (TB1, pin 3) and the second output represents thermoconductivity (TB1, pin 4). These signals may then be used in a TMO2D algorithm to provide an improved oxygen calculation.

Note: *In the following procedure, the gas mixture having the largest oxygen sensitivity should be used as Gas A.*

Set SA1 switches as follows: 1, 3, 5 & 6 = OFF (up position)
2 & 4 = ON
Set J3 to the LO position (HI if using hydrogen/helium).

Zero:

Refer to page D-5, *Zero*, and follow steps 1 through 12, but set E14 to +0.30 volts in step #3 and disregard step #4.

Oxygen Span:

1. Apply span/background Gas A (ex. 10% oxygen, remainder CO_2) into the oxygen transmitter.
2. Adjust S1 and R41 until the TB1-3 is about 20 milliamps.

External Compensation:

1. Apply background Gas B (ex. 100% Hydrogen) into the oxygen transmitter.

2. Adjust R28 until TB1-4 is about 20 milliamps.*****

3. Apply background Gas A (ex. 100% CO_2) into the oxygen transmitter.

4. Adjust R27 until the TB1-4 is about 4 milliamps.*****

5. Repeat steps 1 through 4 until the desired outputs are acquired.

*****These values are arbitrary and may vary somewhat since they will be entered into TMO2D or System 1 calibration tables. The levels should extend from 1 to 35 milliamps, taking all expected gas mixtures into account.

Note: *R27 and R28 are interdependent; adjustment of one pot will affect the setpoint of the other pot.*

Internal Pressure Compensation

The analyzer circuit board can accommodate three types of pressure compensation: Additive, Multiplicative, and External. Additive and multiplicative pressure compensation are performed on the analyzer circuit board, whereas external pressure compensation produces an auxiliary 4-20 (TB1-4) milliamp signal for use in TMO2D compensation calculations.

This section describes additive and multiplying pressure compensation. Additive pressure compensation is used to make corrections on 100% oxygen analyzers. Multiplying should be used on the lower oxygen ranges. Calibration of the auxiliary external pressure signal is covered in the next section.

Additive Comp: Set SA1 switches as follows: 1, 4 & 5 = OFF (up)
2, 3 & 6 = ON

Multiplying Comp: Set SA1 switches as follows: 2, 3 & 6 = OFF
1, 4 & 5 = ON

Set J3 to the LO position (HI if using hydrogen/helium).

Zero:

Refer to page D-5, *Zero*, and follow steps 1 through 12, setting E14 to +2.94 volts (additive comp.) or -0.80 volts (multiplying comp.) in step #3. **(With single background gas systems, use only steps 1 through 6.)**

Span Compensation:

1. Apply span gas (ex. 100% oxygen) into the oxygen transmitter.

2. Adjust S1 and R41 until the output (TB1-3) is 20 milliamps.

3. Apply span pressure to the pressure sensor (ex. 1.0 PSI).

4. Adjust R28 until TB1-3 is 20 milliamps.

5. Apply minspan pressure to the pressure sensor (ex. 0 PSI).

6. Adjust R27 until TB1-3 is 20 milliamps.

7. Repeat steps 3 through 6 until a consistent output is obtained.

Note: *R27 and R28 are interdependent; adjustment of one pot will affect the setpoint of the other pot.*

External Pressure Signal Calibration

This system uses an analyzer with separate oxygen and pressure signal outputs. These signals would normally be used by TMO2D programs to produce a pressure corrected oxygen value.

Set SA1 switches as follows: 1, 4, 5 & 6 =OFF (up)
2 & 3 = ON

Set J3 to the LO position (HI if using hydrogen/helium).

Zero:

Refer to page D-5, *Zero*, and follow steps 1 through 12, setting E14 to +2.0 volts in step #3. **(With single background gas systems, use only steps 1 through 6.)**

Oxygen Span:

1. Apply span/background gas (ex. 10% oxygen, remainder CO_2) into the oxygen transmitter.

2. Adjust S1 and R41 until the TB1-3 is about 15 milliamps.*****

External Pressure Signal:

1. Apply span pressure to the pressure sensor (ex. 1.0 PSI).

2. Adjust R28 until TB1-4 is approximately 20 milliamps.*****

3. Apply minspan pressure to the pressure sensor (ex. 0.0 PSI).

4. Adjust R27 until the output is approximately 10 milliamps.*****

5. Repeat steps 1 through 4 until the desired outputs are obtained.

*****These values are arbitrary and may vary somewhat since they will be entered into TMO2D or System 1 calibration tables. The levels should extend from 1 to 35 milliamps, taking all expected gas mixtures into account.

Note: *R27 and R28 are interdependent; adjustment of one pot will affect the setpoint of the other pot.*

Internal Hydrogen Gas Compensation

Set SA1 switches as follows: 1, 3, 4 & 6 = OFF (up)
2 & 5 = ON

Set J3 to the HI position (HI if using hydrogen/helium).

Zero:

Refer to page D-5, *Zero*, and follow steps 1 through 12, but set E14 to +0.92 volts in step #3, and set E10 to 4.0 volts in step #4.

Span Compensation:

Refer to page D-6, *Span Compensation*, and follow steps 1 through 7.

External Hydrogen Gas Compensation

Refer to page D-6, *External Compensation*, but set J3 to the HI position.

Internal Methane Gas Compensation (Reverse Compensation)

Set SA1 switches as follows: 2, 4 & 6 = OFF (up)
1, 3 & 5 = ON

Set J3 to the LO position (HI if using hydrogen/helium).

Zero:

Refer to page D-5, *Zero*, and follow steps 1 through 12, setting E14 to -3.15 volts in step #3.

Span Compensation:

Refer to page D-6, *Span Compensation*, and follow steps 1 through 7.

Appendix E

Main Menu Flow Diagrams

Setup and Recorder Menu Flow Diagrams E-1

Alarm and Test Menu Flow Diagrams. E-3

Calibration Menu Flow Diagram B-1

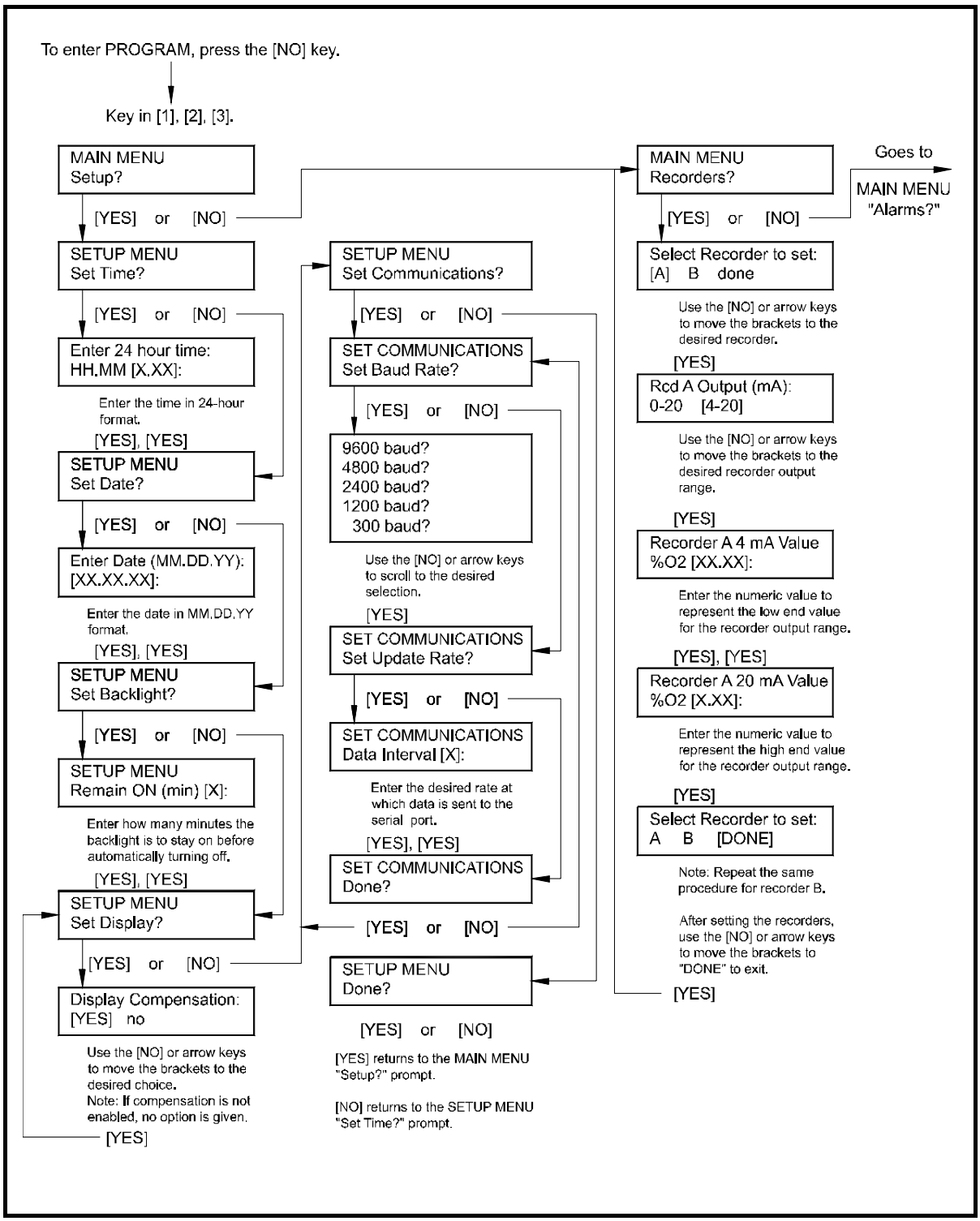

To enter PROGRAM, press the [NO] key.
Key in [1], [2], [3].
MAIN MENU
Setup?
[YES] or [NO]
SETUP MENU
Set Time?
[YES] or [NO]
Enter 24 hour time:
HH.MM [X.XX]:
Enter the time in 24-hour format.
[YES], [YES]
SETUP MENU
Set Date?
[YES] or [NO]
Enter Date (MM.DD.YY):
[XX.XX.XX]:
Enter the date in MM.DD.YY format.
[YES], [YES]
SETUP MENU
Set Backlight?
[YES] or [NO]
SETUP MENU
Remain ON (min) [X]:
Enter how many minutes the backlight is to stay on before automatically turning off.
[YES], [YES]
SETUP MENU
Set Display?
[YES] or [NO]
Display Compensation:
[YES] no
Use the [NO] or arrow keys to move the brackets to the desired choice.
Note: If compensation is not enabled, no option is given.
[YES]
SETUP MENU
Set Communications?
[YES] or [NO]
SET COMMUNICATIONS
Set Baud Rate?
[YES] or [NO]
9600 baud?
4800 baud?
2400 baud?
1200 baud?
300 baud?
Use the [NO] or arrow keys to scroll to the desired selection.
[YES]
SET COMMUNICATIONS
Set Update Rate?
[YES] or [NO]
SET COMMUNICATIONS
Data Interval [X]:
Enter the desired rate at which data is sent to the serial port.
[YES], [YES]
SET COMMUNICATIONS
Done?
[YES] or [NO]
SETUP MENU
Done?
[YES] or [NO]
[YES] returns to the MAIN MENU "Setup?" prompt.
[NO] returns to the SETUP MENU "Set Time?" prompt.
MAIN MENU
Recorders?
[YES] or [NO]
Goes to
MAIN MENU
"Alarms?"
Select Recorder to set:
[A] B done
Use the [NO] or arrow keys to move the brackets to the desired recorder.
[YES]
Rcd A Output (mA):
0-20 [4-20]
Use the [NO] or arrow keys to move the brackets to the desired recorder output range.
[YES]
Recorder A 4 mA Value
%O2 [XX.XX]:
Enter the numeric value to represent the low end value for the recorder output range.
[YES], [YES]
Recorder A 20 mA Value
%O2 [X.XX]:
Enter the numeric value to represent the high end value for the recorder output range.
[YES]
Select Recorder to set:
A B [DONE]
Note: Repeat the same procedure for recorder B.
After setting the recorders, use the [NO] or arrow keys to move the brackets to "DONE" to exit.
[YES]

Figure E-1: Setup and Recorder Menu Flow Diagrams

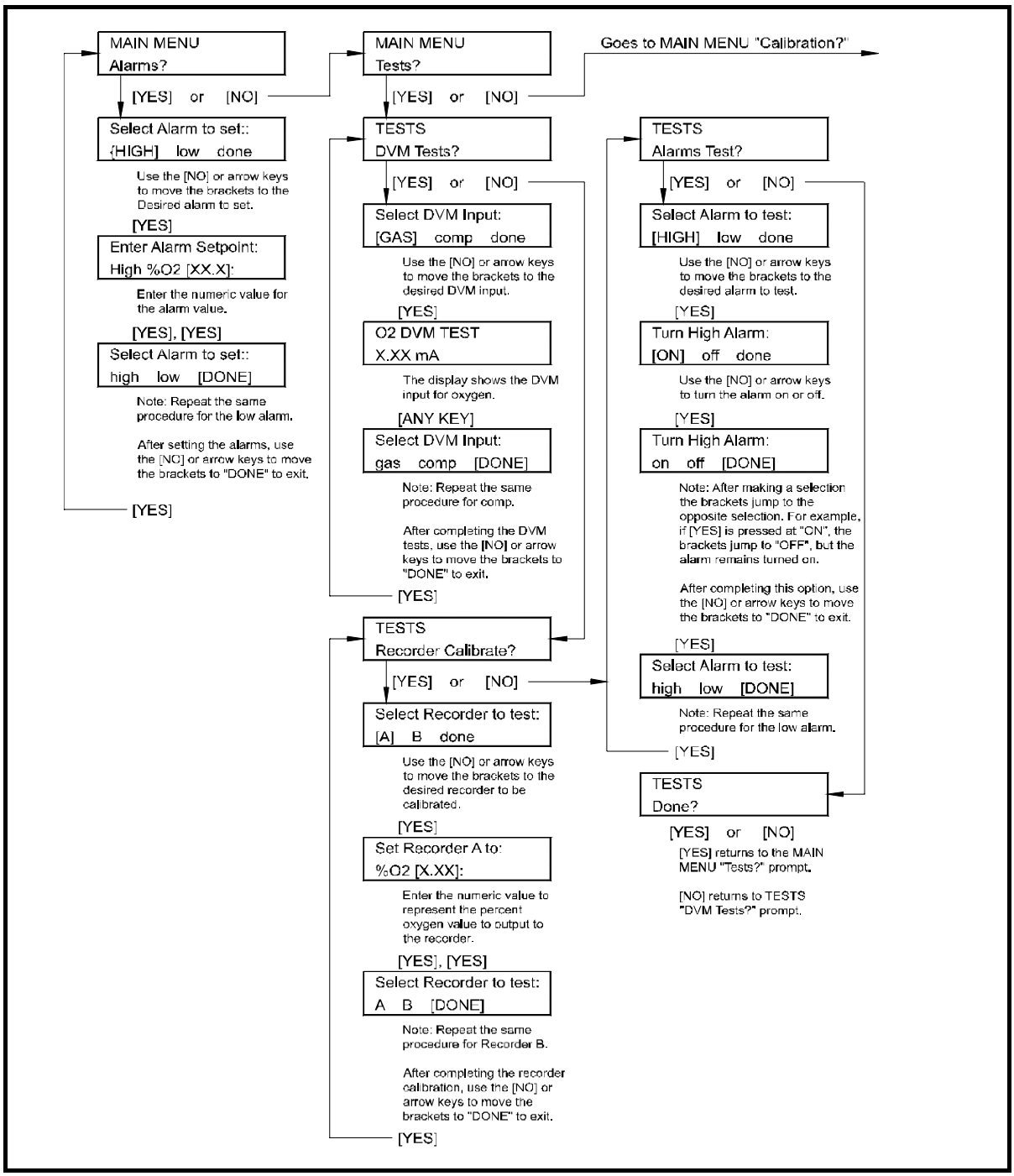

MAIN MENU
Alarms?
[YES] or [NO]
Select Alarm to set::
{HIGH] low done
Use the [NO] or arrow keys to move the brackets to the Desired alarm to set.
[YES]
Enter Alarm Setpoint:
High %O2 [XX.X]:
Enter the numeric value for the alarm value.
[YES], [YES]
Select Alarm to set::
high low [DONE]
Note: Repeat the same procedure for the low alarm.
After setting the alarms, use the [NO] or arrow keys to move the brackets to "DONE" to exit.
[YES]
MAIN MENU
Tests?
[YES] or [NO]
Goes to MAIN MENU "Calibration?"
TESTS
DVM Tests?
[YES] or [NO]
Select DVM Input:
[GAS] comp done
Use the [NO] or arrow keys to move the brackets to the desired DVM input.
[YES]
O2 DVM TEST
X.XX mA
The display shows the DVM input for oxygen.
[ANY KEY]
Select DVM Input:
gas comp [DONE]
Note: Repeat the same procedure for comp.
After completing the DVM tests, use the [NO] or arrow keys to move the brackets to "DONE" to exit.
[YES]
TESTS
Recorder Calibrate?
[YES] or [NO]
Select Recorder to test:
[A] B done
Use the [NO] or arrow keys to move the brackets to the desired recorder to be calibrated.
[YES]
Set Recorder A to:
%O2 [X.XX]:
Enter the numeric value to represent the percent oxygen value to output to the recorder.
[YES], [YES]
Select Recorder to test:
A B [DONE]
Note: Repeat the same procedure for Recorder B.
After completing the recorder calibration, use the [NO] or arrow keys to move the brackets to "DONE" to exit.
[YES]
TESTS
Alarms Test?
[YES] or [NO]
Select Alarm to test:
[HIGH] low done
Use the [NO] or arrow keys to move the brackets to the desired alarm to test.
[YES]
Turn High Alarm:
[ON] off done
Use the [NO] or arrow keys to turn the alarm on or off.
[YES]
Turn High Alarm:
on off [DONE]
Note: After making a selection the brackets jump to the opposite selection. For example, if [YES] is pressed at "ON", the brackets jump to "OFF", but the alarm remains turned on.
After completing this option, use the [NO] or arrow keys to move the brackets to "DONE" to exit.
[YES]
Select Alarm to test:
high low [DONE]
Note: Repeat the same procedure for the low alarm.
[YES]
TESTS
Done?
[YES] or [NO]
[YES] returns to the MAIN MENU "Tests?" prompt.
[NO] returns to TESTS "DVM Tests?" prompt.

Figure E-2: Alarm and Test Menu Flow Diagrams

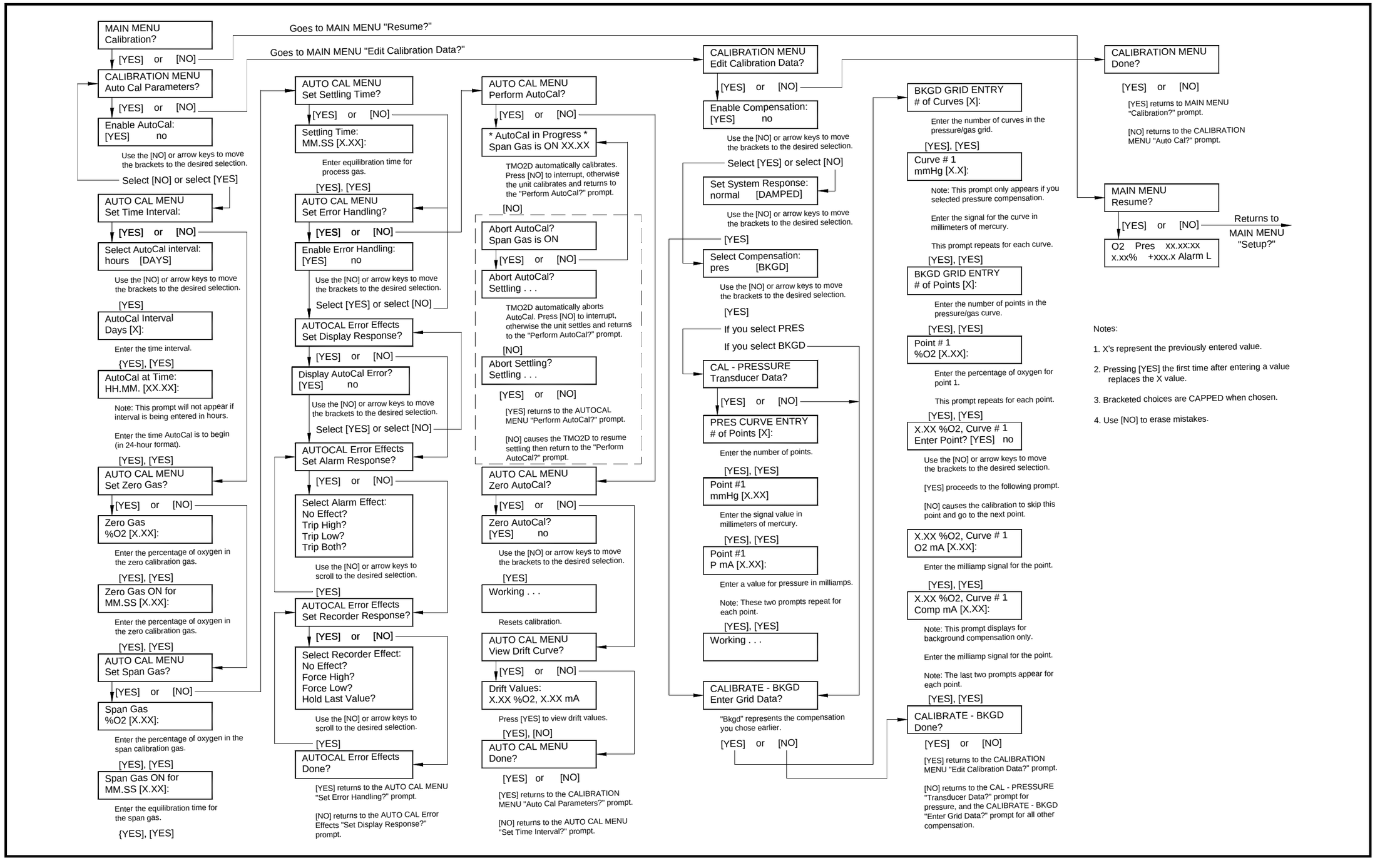

MAIN MENU
Calibration?
[YES] or [NO]
Goes to MAIN MENU "Resume?"
Goes to MAIN MENU "Edit Calibration Data?"
CALIBRATION MENU
Auto Cal Parameters?
[YES] or [NO]
Enable AutoCal:
[YES] no
Use the [NO] or arrow keys to move the brackets to the desired selection.
Select [NO] or select [YES]
AUTO CAL MENU
Set Time Interval:
[YES] or [NO]
Select AutoCal interval:
hours [DAYS]
Use the [NO] or arrow keys to move the brackets to the desired selection.
[YES]
AutoCal Interval
Days [X]:
Enter the time interval.
{YES], [YES]
AutoCal at Time:
HH.MM. [XX.XX]:
Note: This prompt will not appear if interval is being entered in hours.
Enter the time AutoCal is to begin (in 24-hour format).
[YES], [YES]
AUTO CAL MENU
Set Zero Gas?
[YES] or [NO]
Zero Gas
%O2 [X.XX]:
Enter the percentage of oxygen in the zero calibration gas.
[YES], [YES]
Zero Gas ON for
MM.SS [X.XX]:
Enter the percentage of oxygen in the zero calibration gas.
[YES], [YES]
AUTO CAL MENU
Set Span Gas?
[YES] or [NO]
Span Gas
%O2 [X.XX]:
Enter the percentage of oxygen in the span calibration gas.
[YES], [YES]
Span Gas ON for
MM.SS [X.XX]:
Enter the equilibration time for the span gas.
{YES], [YES]
AUTO CAL MENU
Set Settling Time?
[YES] or [NO]
Settling Time:
MM.SS [X.XX]:
Enter equilibration time for process gas.
[YES], [YES]
AUTO CAL MENU
Set Error Handling?
[YES] or [NO]
Enable Error Handling:
[YES] no
Use the [NO] or arrow keys to move the brackets to the desired selection.
Select [YES] or select [NO]
AUTOCAL Error Effects
Set Display Response?
[YES] or [NO]
Display AutoCal Error?
[YES] no
Use the [NO] or arrow keys to move the brackets to the desired selection.
Select [YES] or select [NO]
AUTOCAL Error Effects
Set Alarm Response?
[YES] or [NO]
Select Alarm Effect:
No Effect?
Trip High?
Trip Low?
Trip Both?
Use the [NO] or arrow keys to scroll to the desired selection.
[YES]
AUTOCAL Error Effects
Set Recorder Response?
[YES] or [NO]
Select Recorder Effect:
No Effect?
Force High?
Force Low?
Hold Last Value?
Use the [NO] or arrow keys to scroll to the desired selection.
[YES]
AUTOCAL Error Effects
Done?
[YES] returns to the AUTO CAL MENU "Set Error Handling?" prompt.
[NO] returns to the AUTO CAL Error Effects "Set Display Response?" prompt.
AUTO CAL MENU
Perform AutoCal?
[YES] or [NO]
* AutoCal in Progress *
Span Gas is ON XX.XX
TMO2D automatically calibrates. Press [NO] to interrupt, otherwise the unit calibrates and returns to the "Perform AutoCal?" prompt.
[NO]
Abort AutoCal?
Span Gas is ON
[YES] or [NO]
Abort AutoCal?
Settling . . .
TMO2D automatically aborts AutoCal. Press [NO] to interrupt, otherwise the unit settles and returns to the "Perform AutoCal?" prompt.
[NO]
Abort Settling?
Settling . . .
[YES] or [NO]
[YES] returns to the AUTOCAL MENU "Perform AutoCal?" prompt.
[NO] causes the TMO2D to resume settling then return to the "Perform AutoCal?" prompt.
AUTO CAL MENU
Zero AutoCal?
[YES] or [NO]
Zero AutoCal?
[YES] no
Use the [NO] or arrow keys to move the brackets to the desired selection.
[YES]
Working . . .
Resets calibration.
AUTO CAL MENU
View Drift Curve?
[YES] or [NO]
Drift Values:
X.XX %O2, X.XX mA
Press [YES] to view drift values.
[YES], [NO]
AUTO CAL MENU
Done?
[YES] or [NO]
[YES] returns to the CALIBRATION MENU "Auto Cal Parameters?" prompt.
[NO] returns to the AUTO CAL MENU "Set Time Interval?" prompt.
CALIBRATION MENU
Edit Calibration Data?
[YES] or [NO]
Enable Compensation:
[YES] no
Use the [NO] or arrow keys to move the brackets to the desired selection.
Select [YES] or select [NO]
Set System Response:
normal [DAMPED]
Use the [NO] or arrow keys to move the brackets to the desired selection.
[YES]
Select Compensation:
pres [BKGD]
Use the [NO] or arrow keys to move the brackets to the desired selection.
[YES]
If you select PRES
If you select BKGD
CAL - PRESSURE
Transducer Data?
[YES] or [NO]
PRES CURVE ENTRY
# of Points [X]:
Enter the number of points.
[YES], [YES]
Point #1
mmHg [X.XX]
Enter the signal value in millimeters of mercury.
[YES], [YES]
Point #1
P mA [X.XX]:
Enter a value for pressure in milliamps.
Note: These two prompts repeat for each point.
[YES], [YES]
Working . . .
CALIBRATE - BKGD
Enter Grid Data?
"Bkgd" represents the compensation you chose earlier.
[YES] or [NO]
BKGD GRID ENTRY
# of Curves [X]:
Enter the number of curves in the pressure/gas grid.
[YES], [YES]
Curve # 1
mmHg [X.X]:
Note: This prompt only appears if you selected pressure compensation.
Enter the signal for the curve in millimeters of mercury.
This prompt repeats for each curve.
[YES], [YES]
BKGD GRID ENTRY
# of Points [X]:
Enter the number of points in the pressure/gas curve.
[YES], [YES]
Point # 1
%O2 [X.XX]:
Enter the percentage of oxygen for point 1.
This prompt repeats for each point.
[YES], [YES]
X.XX %O2, Curve # 1
Enter Point? [YES] no
Use the [NO] or arrow keys to move the brackets to the desired selection.
[YES] proceeds to the following prompt.
[NO] causes the calibration to skip this point and go to the next point.
X.XX %O2, Curve # 1
O2 mA [X.XX]:
Enter the milliamp signal for the point.
[YES], [YES]
X.XX %O2, Curve # 1
Comp mA [X.XX]:
Note: This prompt displays for background compensation only.
Enter the milliamp signal for the point.
Note: The last two prompts appear for each point.
[YES], [YES]
CALIBRATE - BKGD
Done?
[YES] or [NO]
[YES] returns to the CALIBRATION MENU "Edit Calibration Data?" prompt.
[NO] returns to the CAL - PRESSURE "Transducer Data?" prompt for pressure, and the CALIBRATE - BKGD "Enter Grid Data?" prompt for all other compensation.
CALIBRATION MENU
Done?
[YES] or [NO]
[YES] returns to MAIN MENU "Calibration?" prompt.
[NO] returns to the CALIBRATION MENU "Auto Cal?" prompt.
MAIN MENU
Resume?
[YES] or [NO]
Returns to MAIN MENU "Setup?"
O2 Pres xx.xx:xx
x.xx% +xxx.x Alarm L
Notes:
1. X's represent the previously entered value.
2. Pressing [YES] the first time after entering a value replaces the X value.
3. Bracketed choices are CAPPED when chosen.
4. Use [NO] to erase mistakes.

Figure E-3: Calibration Menu Flow Diagram

Appendix F

Installation Instructions for CE Mark Compliance

Installation Instructions for CE Mark Compliance

NOTICE
CE MARK COMPLIANCE IS REQUIRED ONLY FOR UNITS USED IN EEC COUNTRIES.

For CE Mark compliance, the TMO2D must be enclosed in a NEMA-4 stainless steel case. In addition, you must shield and ground the electrical connections as shown in Table F-1 below.

Note: *If you make the modifications as discussed in this appendix, your unit will comply with the EMC Directive 89/336/EEC.*

Table F-1: Wiring Modifications for CE Compliance

Connection	Termination Modification
Power	1. When connecting power, select the cable entry closest to the chassis ground. 2. Connect the power ground to the nearest chassis ground using the shortest run of wire possible. Grounding lugs are provided in the TMO2D enclosure.
Input/Output	1. Use shielded cable to interconnect system enclosures. 2. Connect the shields to the nearest chassis ground using the shortest run of wire possible. Grounding lugs are provided in the TMO2D enclosure.

After you make all the necessary electrical connections, seal unused cable entry holes with standard conduit plugs or equivalent.

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DECLARATION OF CONFORMITY

PANAMETRICS

We,

Panametrics Limited
Shannon Industrial Estate
Shannon, Co. Clare
Ireland

declare under our sole responsibility that the

TMO2D Display and Control Module

to which this declaration relates is in conformity with the following standards:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
- EN 61010-1:1993 + A2:1995, Overvoltage Category II, Pollution Degree 2

following the provisions of 89/336/EEC EMC Directive and 73/23/EEC Low Voltage Directive.

Shannon - August 1, 2001

Mr. James Gibson
GENERAL MANAGER

CE

I.S. EN ISO 9002
Shannon

TÜV
TÜV ESSEN
ISO 9001
U.S.

DECLARATION DE CONFORMITE

PANAMETRICS

Nous,

Panametrics Limited
Shannon Industrial Estate
Shannon, Co. Clare
Ireland

déclarons sous notre propre responsabilité que le

TMO2D Display and Control Module

rélatif á cette déclaration est en conformité avec les documents suivants:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
- EN 61010-1:1993 + A2:1995, Overvoltage Category II, Pollution Degree 2

suivant les régles de la Directive de Compatibilité Electromagnétique 89/336/EEC et de la Directive Basse Tension 73/23/EEC.

Shannon - August 1, 2001

Mr. James Gibson
GENERAL MANAGER

CE

I.S. EN ISO 9002
Shannon

TÜV ESSEN
ISO 9001
U.S.

KONFORMITÄTSERKLÄRUNG

PANAMETRICS

Wir,

Panametrics Limited
Shannon Industrial Estate
Shannon, Co. Clare
Ireland

erklären, in alleiniger Verantwortung, daß das Produkt

TMO2D Display and Control Module

folgende Normen erfüllt:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
- EN 61010-1:1993 + A2:1995, Overvoltage Category II, Pollution Degree 2

gemäß den Europäischen Richtlinien, Niederspannungsrichtlinie Nr.: 73/23/EWG und EMV-Richtlinie Nr.: 89/336/EWG.

Shannon - August 1, 2001

Mr. James Gibson
GENERAL MANAGER

CE

I.S. EN ISO 9002
Shannon

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TÜV ESSEN
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ISO 9001
CERTIFIED

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